Welding Engineer

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APRIL, 1959

Welding Show Issue

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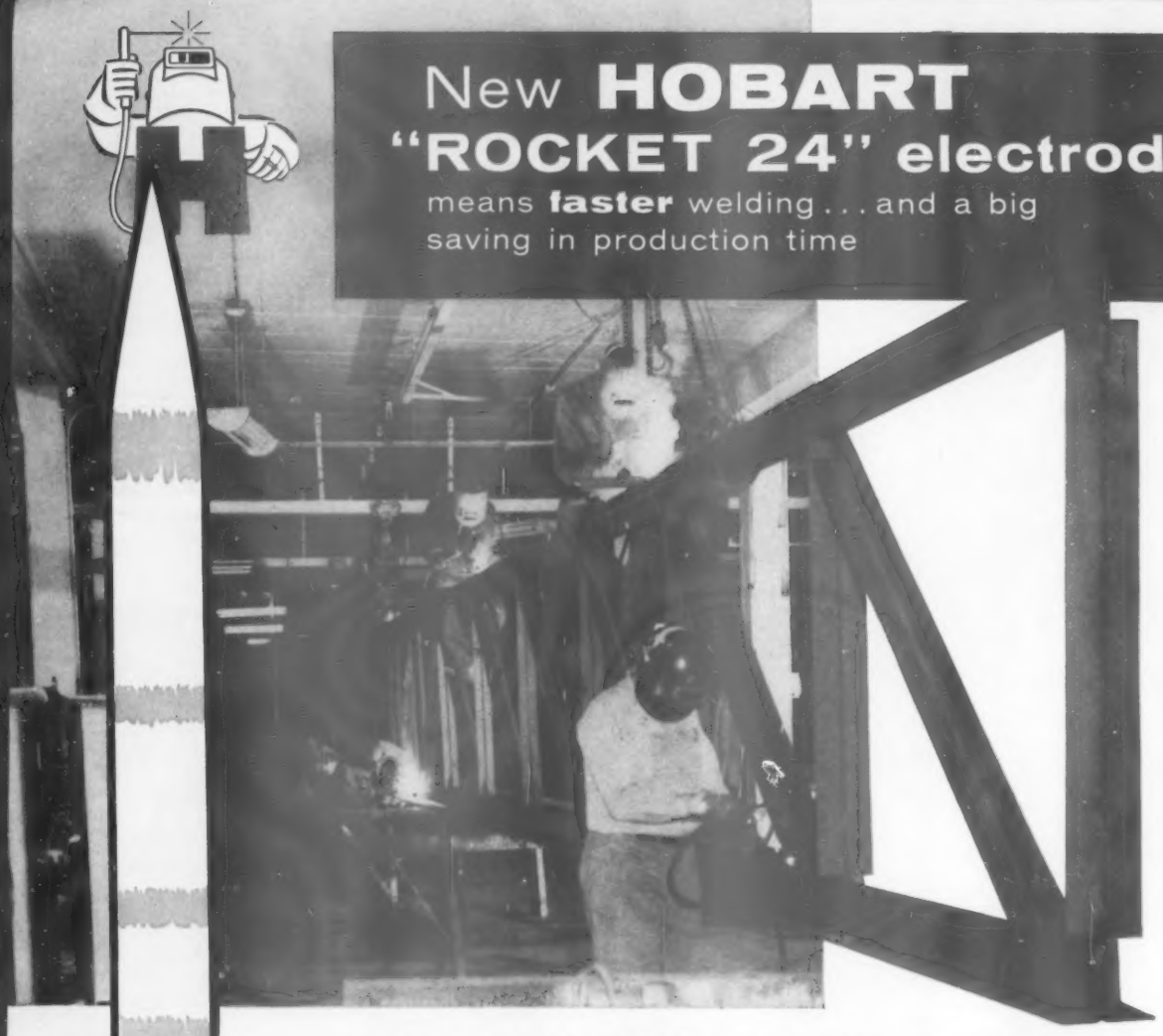

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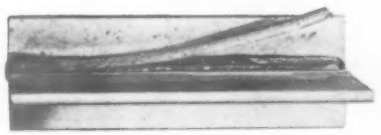

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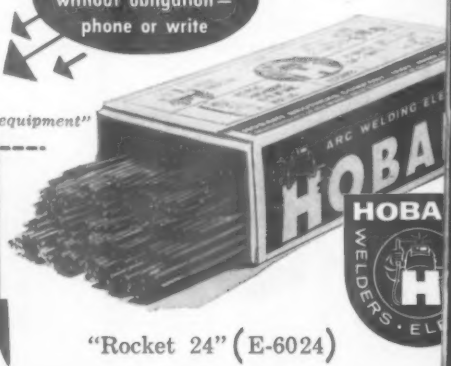

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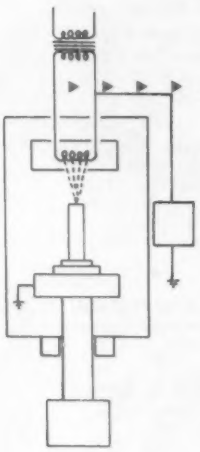
Vol. 44—No. 4

Welding Engineer

The magazine of joining and severing materials

This is welding: April, 1959



AWS expects 15,000 persons at Seventh Annual Welding Show 36

Electron beam welding—a new development for industry 38

Highly reactive metals and alloys used for nuclear fuel components demanded development of a new welding process. **W. I. Steinkamp** and **W. L. Wyman** report on this nuclear-age joining method.

Application data on Kaiser's new Mig techniques 44

Three new methods for Mig welding were first announced in **WE** last year. Now procedures and welding data have been released, and are detailed here by **M. B. Kasen, George Allen** and **F. R. Baysinger.**

Filler metals for joining 48

In his final article in this series, **Orville T. Barnett** discusses automatic welding wires and suggests specifications.

Electro-molding replaces forged engine components 52

Author **R. L. Peterson** relates how a modified submerged-arc welding method proved to be the answer to the high cost of forged locomotive engine components.

Explosive welding and forming open another door for industry 61

In recent months, use of explosives for bonding, forming and welding has received much attention. **Jack Fairlie** relates his findings after a visit to one pioneer in this new field.

Stainless steel overlay coats an "ulcered stomach" 82

Digesters process wood chips into paper and pulp with gas and hot liquids, but wall corrosion and erosion is an unwanted by-product. Mig-applied stainless overlay corrected the problem.

A new unit solves multiple spot welding problems 90

Compact and powerful, a recently introduced welding unit promises to eliminate previously difficult problems in multiple spot welding of thin gage sheet metal.

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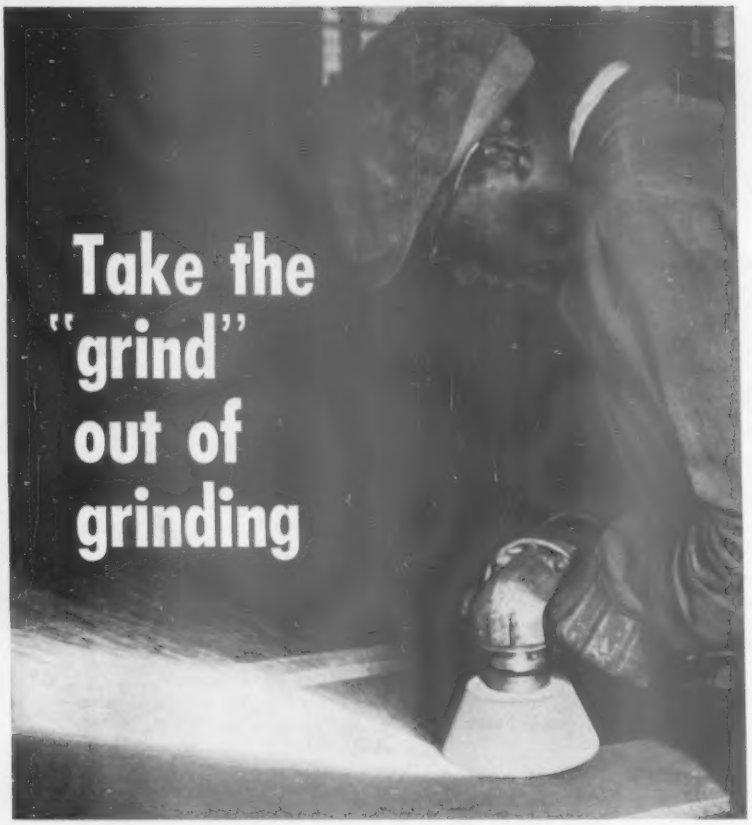

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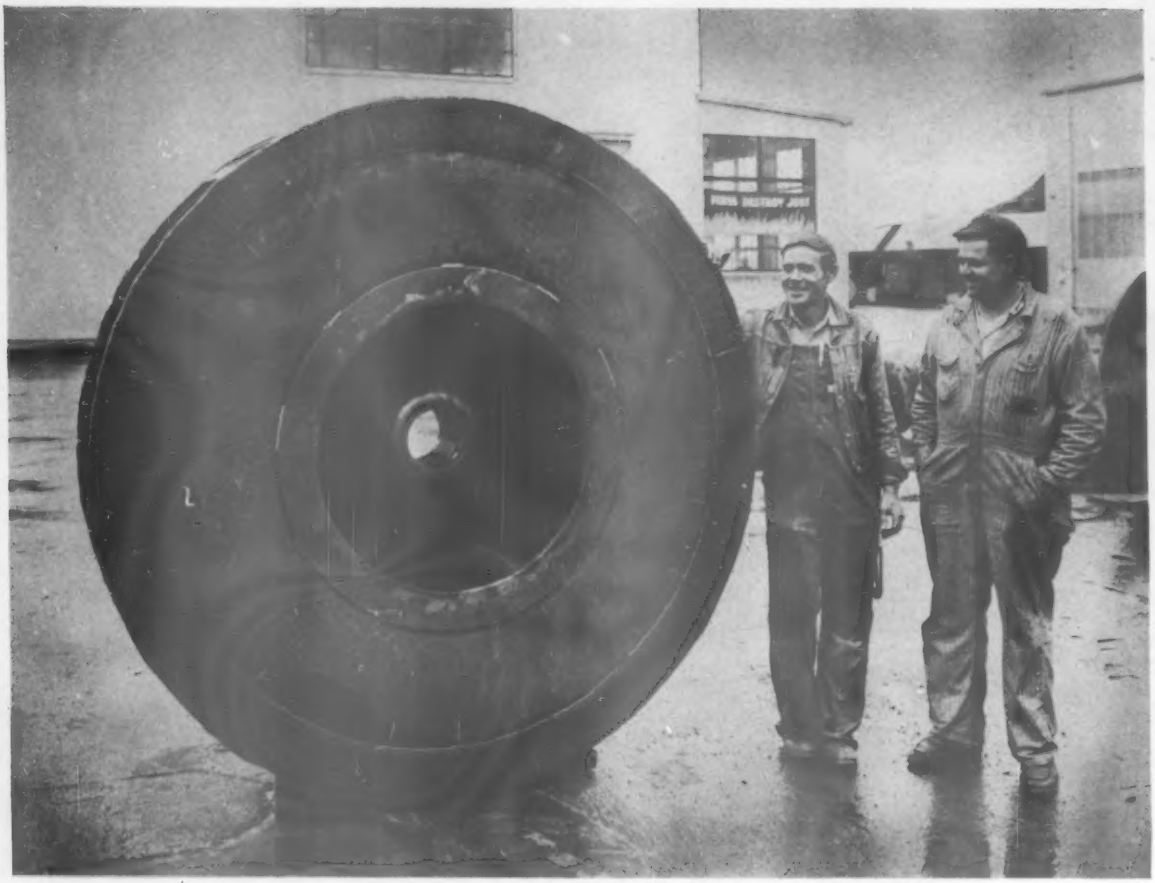
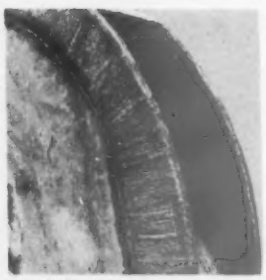


Cuts hardfacing time in 1/2 with Victor semi-automatic Wire



When this 84" dredge pump impeller's action became sloppy from 250,000 cu. yds. of abrasive river material, The Corps of Engineers at Portland, Oregon, built it back to proper size and shape with Victor semi-automatic hardfacing wire.

For the multiple build-up required, welder Maynard Berry (left in photo) used Victor VA-4X 7/16" wire. Then he deposited a top pass with VA-0 7/16" wire, especially resistant to abrasion. Photos here show how neatly he and Victor semi-automatic wire did the job.

Reports welding foreman D. L. Brumbaugh:

"One-half the hard-facing time was saved. We have had exceptionally good quality weld deposit with Victor and we like its running quality."

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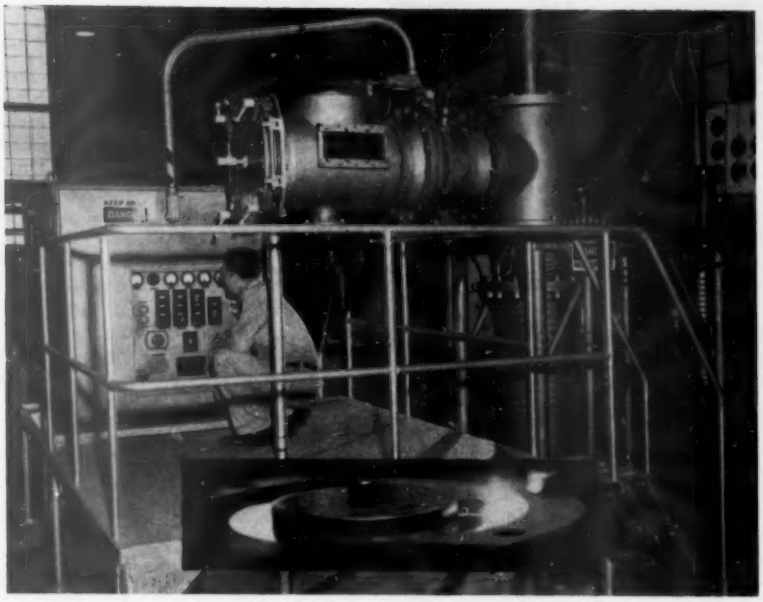


ELECTRON beam welder, which can join reactive and high-melting-point metals used in critical missile and atomic reactor applications, was designed and constructed by Air Reduction Co.'s Central Research Laboratories, Murray Hill, N. J. Welder applies electron beam to weld beryllium, molybdenum, tantalum, and other exotic metals. Electron beam bombards materials to be welded in a very high vacuum chamber which makes it impossible for pieces to be contaminated during welding. Inset, interior view of test chamber showing materials being welded. Electron beam can be as small as 1/16-in. diameter. Application of process requires custom built equipment for specific jobs. (See "Electron beam welding—a new development for industry," in this issue.)

COMING EVENTS

APRIL 6-10: AWS National Spring Meeting, Hotel Sherman, Chicago.

APRIL 7-9: AWS Welding Show, International Amphitheatre, Chicago.

APRIL 16-30: Engineering, Marine, Welding and Nuclear Energy Exhibition, Olympia, London, England.

APRIL 18-22: ASTE Annual Meeting, Schroeder Hotel, Milwaukee.

MAY 4-6: NWSA Annual Convention, Fairmount Hotel, San Francisco.

MAY 5-6: Canadian Welding Society, Second Annual Welding Convention, Exhibition Park, Toronto.

MAY 5-6: Canadian Welding Society, Welding Show, Exhibition Park, Toronto.

MAY 20-22: Society for Experimental Stress Analysis Spring Meeting and Exhibition, Sheraton Park Hotel, Washington, D. C.

MAY 25-28: Design Engineering Show and Conference, Convention Hall, Philadelphia.

MAY 25-27: Annual Convention and Industry Production & Quality Control Exposition, Public Hall, Cleveland.

JUNE 4-5: NEMA Arc Welding Section Quarterly Meeting, Hot Springs, Va.

JUNE 15-26: Ohio State University Summer Course on Fundamentals of Welding Engineering, Sponsored by Dept. of Welding Engineering, Columbus.

SEPT. 28-OCT. 1: National Fall Meeting of the AWS, Detroit.

NOV. 2-6: 41st National Metal Exposition and Congress, International Amphitheatre, Chicago.

A. O. Smith changes electrode pricing format

The Welding Products Division of A. O. Smith Corp., Milwaukee, has announced a major change in the pricing format of welding electrodes —the first such change in the industry in a long time.

The new setup offers purchasers who buy in lots of 40,000 lb or more a reduction incentive that will result in up to 12% savings.

Up to now, buyers in the 40,000-lb-and-over bracket paid the same as those purchasers of 20,000 to 39,999 lb lots.

G. E. Kemper, manager of the division, says the move will also be advantageous to distributors. They will obtain maximum pricing benefits on 20,000 lb orders, instead of on 40,000 lb orders, as has been the industry's practice.

Distributor's will also be able to enjoy greater percentage of profit in the ranges where they sell 95% of their electrode products, says Kemper.

The A. O. Smith announcement, Kemper points out, comes at a time when many large users of electrodes are beginning to stockpile against a possible strike in the steel industry.

NEWS

General Telephone, Sylvania in merger

Share owners of General Telephone Corp., New York City, and Sylvania Electric Products Inc., Boston, have approved the merger of Sylvania into General. The new corporate name is General Telephone & Electronics Corp.

Donald C. Power, president of General, is chairman of the board and chief executive officer of the combined corporation. Don G. Mitchell is president, and will continue as chairman of Sylvania, which will operate as a separate company, wholly-owned by General.

Linde to build Alabama oxygen plant

Linde Co., New York City, will build a 100,000,000-cu-ft-per-month oxygen and nitrogen plant near Huntsville, Ala., in the vicinity of the Redstone Arsenal.

The plant, to be completed in 1960, will supply southern aircraft and missile firms as well as steel, chemical, petroleum and food firms.

Kaiser to move offices from Chicago to Oakland

Kaiser Aluminum & Chemical Corp. will move its general sales offices from Chicago to Oakland, Calif., this summer. The move is being made in an effort to consolidate the company's policy-making groups.

An executive office will be retained in Chicago, along with present regional and district sales headquarters. Also, personnel whose activity is primarily concerned with technical and field service in the Midwest and East, will remain in Chicago.

Welded-rail advantages told by Baer of NCG

The advantages of welded railway tracks and the pioneering Great Northern Railway Co. is making in laying welded-rail was explained by Robert Baer, National Cylinder Gas Div., Chicago, at the recent meeting of the Northwest Maintenance of Way Club at St. Paul.

Baer said Great Northern will make 20,000 welds this year using the NCG Continuous Rail Welding System (See "Swiss rail-welder in production at NCG," p. 35, January).

RWMA publishes bulletin on welding of Inconel

Bulletin 26, the latest publication of the Resistance Welder Manufacturers' Association, Philadelphia, covers "Spot welding Inconel X in thickness range of 0.032 to 0.188 in."

The booklet covers properties of Inconel X, welding with tri-phase d-c machines, welding with single phase a-c machines, postweld heat and forging pressure, X-ray examination and spot weld macrographic examination.

Copies can be had from Association headquarters, 1900 Arch St., Philadelphia 3, Pa. Each copy costs $.20.

Stitt on program at Naval Gun factory

J. R. Stitt, research and welding engineer for the R. C. Mahon Co., Detroit, was among 10 welding experts who were to give lectures during February before top level personnel at the United States Naval Gun Factory, Washington, D. C.

The 10 lecturers were to take part in a special two-week review sponsored by the Navy to learn more about arc welding processes. Stitt was to give two lectures, one on the problems of setting up arc welding specifications and another on the duties of welding inspectors.

Prior to joining Mahon, Stitt was an associate professor at Ohio State University, where he organized the first complete curriculum in welding engineering leading to a degree.

IAA makes posthumous award to H. F. Reinhard

The International Acetylene Association has made a special posthumous award of the James Turner Morehead Medal to Herbert F. Reinhard, who died last spring. He had been IAA secretary for 27 years.

The Medal was presented recently to Mrs. Reinhard at a special luncheon in New York City.

Tube Turns produces bellows expansion joints

Tube Turns, Louisville, a division of Chemetron Corp., has entered the flexible piping components field, and has recently introduced a complete line of bellows expansion joints that have test-rated cyclic life.

This is the first of many new products and market developments planned by the producers of welding fittings and flanges, according to Tube Turns president, John G. Seiler.

Combustion Engineering acquires General Nuclear

Combustion Engineering Inc., New York City, has acquired General Nuclear Engineering Corp., a nuclear engineering and consulting firm. General Nuclear will be operated as a subsidiary.

Dr. Walter H. Zinn, who headed General Nuclear, was elected a vice president of Combustion Engineering. He will be in charge of all company nuclear power activities.

Welding included in ASM southern conference

A welding paper will be presented as part of the American Society for Metals Southern Metals Conference to be held in the Bon Air Hotel at Augusta, Ga., May 4 to 6. Theme of the conference, to be hosted by the Savannah River Chapter of ASM, is "Metallurgical frontiers."

"Frontiers in welding," will be presented by R. M. Gustafson, Bureau of Aeronautics, Washington, D. C., at the May 4 afternoon session. Also included on the agenda is a guided tour of the Savannah River Atomic Energy Plant.

Welded aluminum cranes being made for Navy

Harnischfeger Corp., Milwaukee, is fabricating two overhead electric traveling cranes for the Navy from aluminum supplied by Kaiser Aluminum & Chemical Sales Inc., Chicago. The all-aluminum cranes, believed to be the first ever fabricated for use outside the crane and aluminum industries, will be installed at the Naval Shipyard in Portsmouth, N. H.

Both cranes are cab-controlled, will have a 102-ft bridge, a 45-ton main hoist and 5-ton auxiliary hoist.

Development of high-strength, weldable aluminum alloys for girders and components and high-speed welding and torch-cutting techniques paved the way for construction of the cranes.

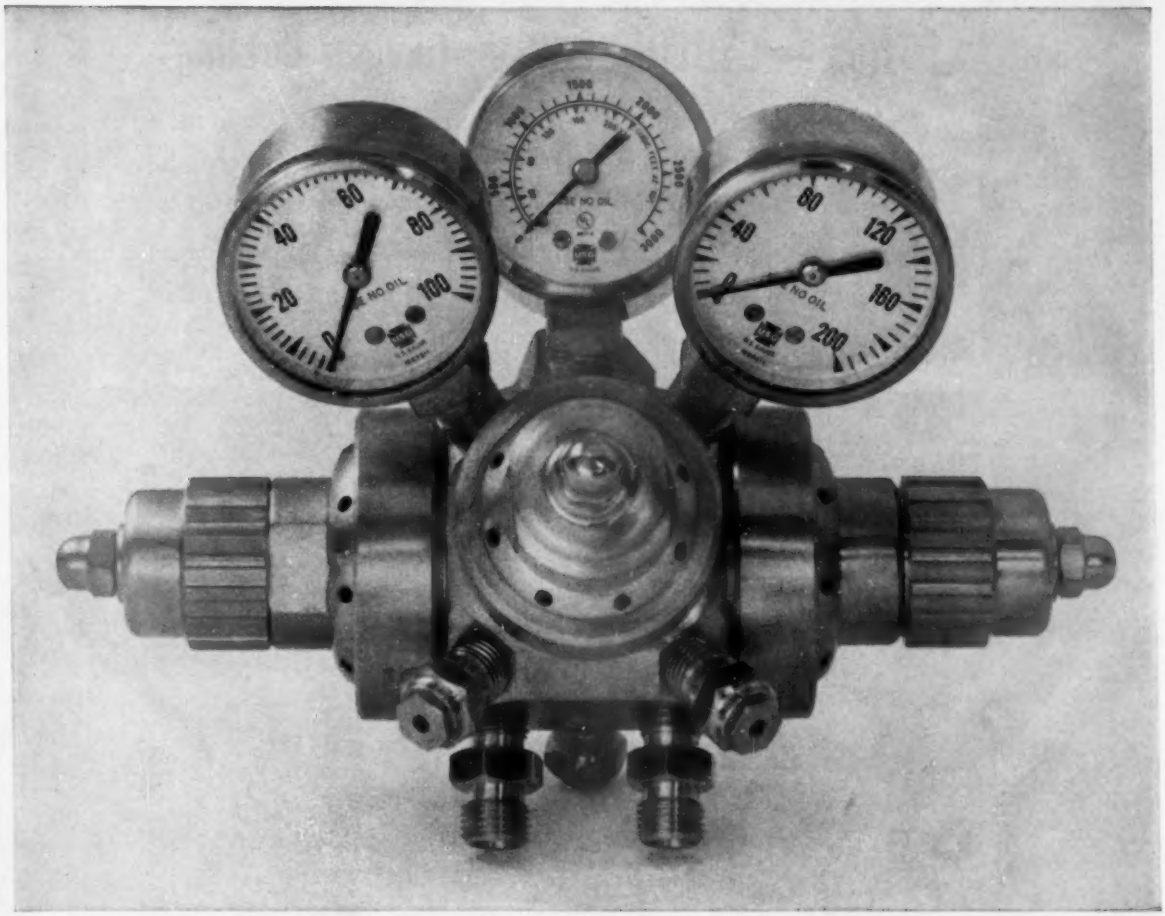
Kaiser first installed aluminum

(Continued on page 115)

EDUCATIONAL Activities Committee of AWS met at Department of Welding Engineering, Ohio State University, Columbus, recently. Prof. R. B. McCauley, left, chairman of department, describes its operations. Other members are, left to right, I. Betz, Frankford Arsenal; R. Nottenburg, International Correspondence School; M. Strong, Trade & Industrial Education, OSU; C. Jackson, Linde Co.; S. Walter, Air Reduction Sales Co.; A. Phillips, AWS; T. Jones, Precision Welder & Flexopress Corp.; H. Cary, Hobart Bros. Co.; R. Minga, Linde Co.; H. Hogan, U. S. Office of Education; H. Sosnin, Tube Turns and W. Leaman, North American Aviation.

MAYOR William P. Donnelly of Butte, Mont., turns a valve that places in operation a new 1,500,000-cu-ft liquid oxygen storage tank at Butte plant of Linde Co., Div. of Union Carbide Corp. Looking on are, left to right, M. P. Merkle, plant superintendent; Glen Bliss, manager of General Distributing Co., Great Falls, Mont.; R. H. Argo, area production superintendent of Linde; Bourke MacDonald, vice president of Butte Chamber of Commerce, and Harold McGrath, secretary-manager of CC. New liquid unit will make available at any time a supply of oxygen that formerly took the Butte plant a month to produce.

For Three Hose Cutting Torches . . . SEPARATE REGULATION



THE NEW TRIPLEX OXYGEN REGULATOR for three-hose flame cutting torches.

Here is a brand new regulator combining into a single unitary body one high pressure stage and two individually adjustable low pressure stages; one low pressure stage to control the preheating flame oxygen and the other one for the high pressure stream of cutting oxygen. The regulator is provided with two outlets, three self-reseating relief valves to protect each individual stage and one inlet. Three 2½" diameter gauges indicate respectively, the low pressure oxygen stream, the high pressure oxygen stream and, the center gauge, the cylinder or cylinder bank pressure. The regulator body and caps are machined of dense brass bar stock, and all internal working parts are interchangeable with all other standard regulators of comparable diameters made by our company. This new Model 5-121, National Triplex Safety Regulator will be of interest to all companies operating three-hose machine cutting torches — write for catalog FORM #16.

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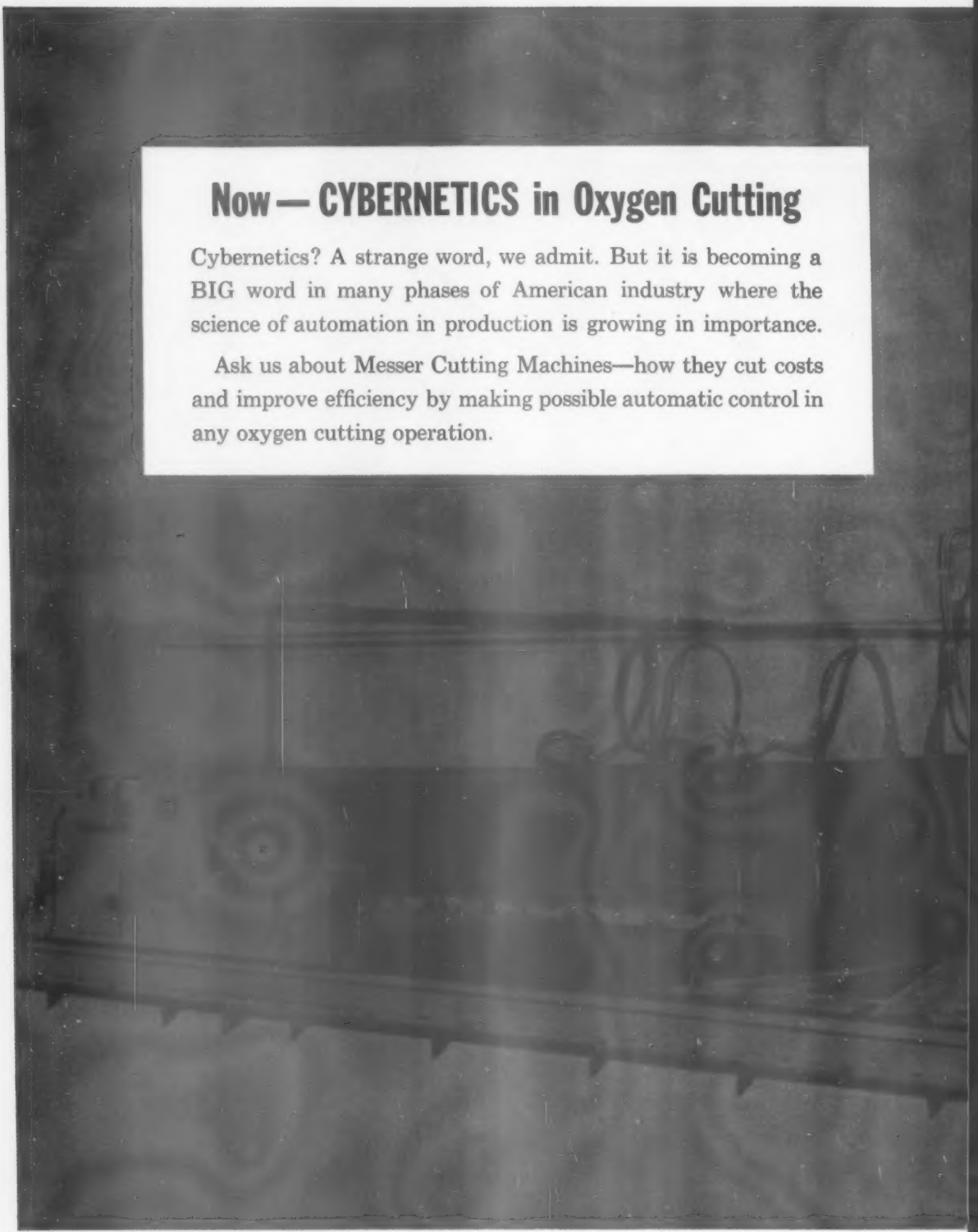

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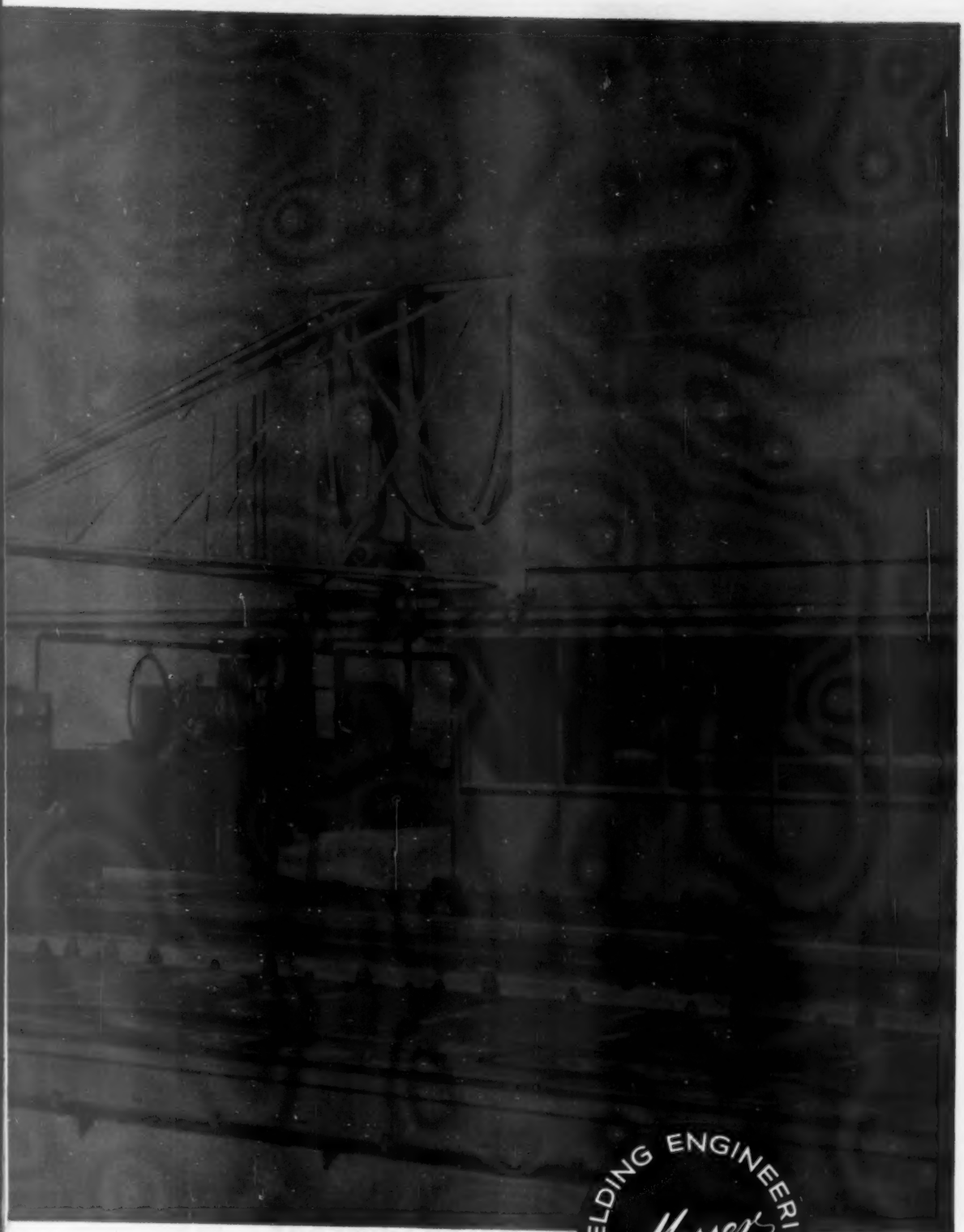

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- Uses money-saving Pureco CO_2 as shielding gas.
- The basic equipment welds all weldable metals.

The Airco Dip Transfer CO_2 Process gives you consistently *high quality* welds at *lower costs* than any other process. For complete information, phone or write your nearest Air Reduction Representative. Ask for the new 24-page "AIRCOMATIC CO_2 WELDING" Catalog.

Visit our booth 521—April 7-8-9 at the Welding Show—International Amphitheatre, Chicago, Ill.

Pureco CO_2 is supplied by the Pure Carbonic Company, a division of Air Reduction Company, Incorporated.
†Trademark
**Patent Applied For

AIRCO®

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated
150 East 42nd Street, New York 17, N. Y.

Offices and authorized dealers in most principal cities

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In Cuba—
Cuban Air Products Corporation
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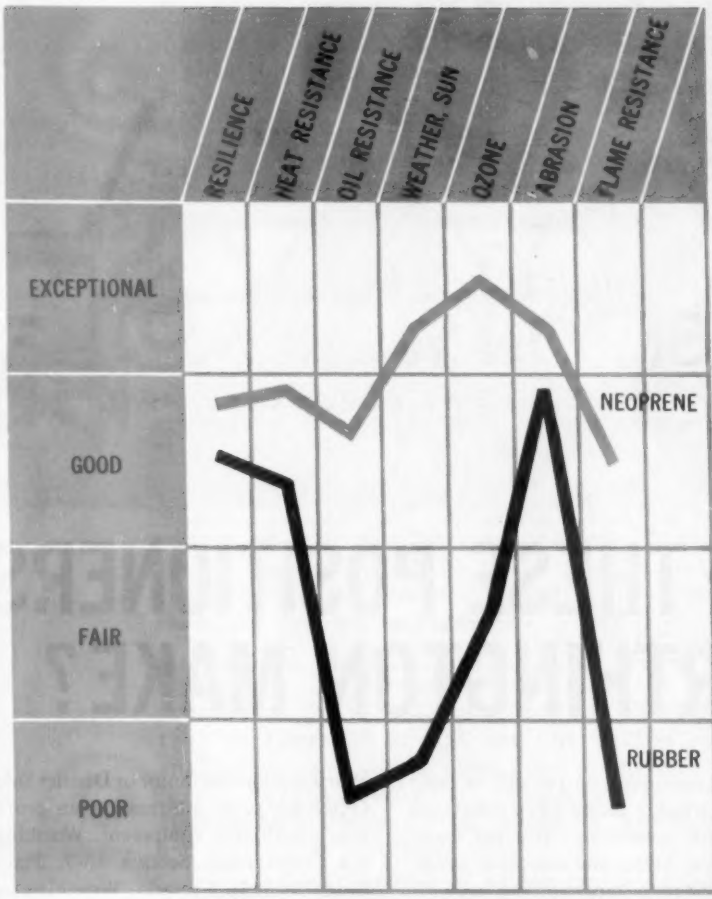
All divisions or subsidiaries of Air Reduction Company, Inc.

HERE'S PROOF THAT **PHELPS DODGE HABIRPRENE** (NEOPRENE) **ARC WELDING CABLE** IS STRONGER, LASTS LONGER!



(Adapted from chart of Elastomer Chemical Dept., E. I. du Pont de Nemours & Co., Inc.)

Phelps Dodge Habirprene arc welding cable combines maximum flexibility with the greatest resistance to deterioration caused by exposure to harmful physical, chemical and mechanical conditions. The ability of Habirprene welding cable to withstand greater overall wear and tear, as compared to rubber welding cable, is shown in this chart compiled from comparison tables of four rubber goods manufacturers.

Phelps Dodge pioneered the fabrication of Habirprene welding cable, the first real advance in this field, more than 10 years ago. Records show that Habirprene cable lasts much longer than rubber cable and—in some applications—as much as *four times longer!* Although the initial cost of Habirprene is slightly higher, it will more than repay you in long-time service. Habirprene arc welding cable meets full requirements of A. S. T. M. D752.

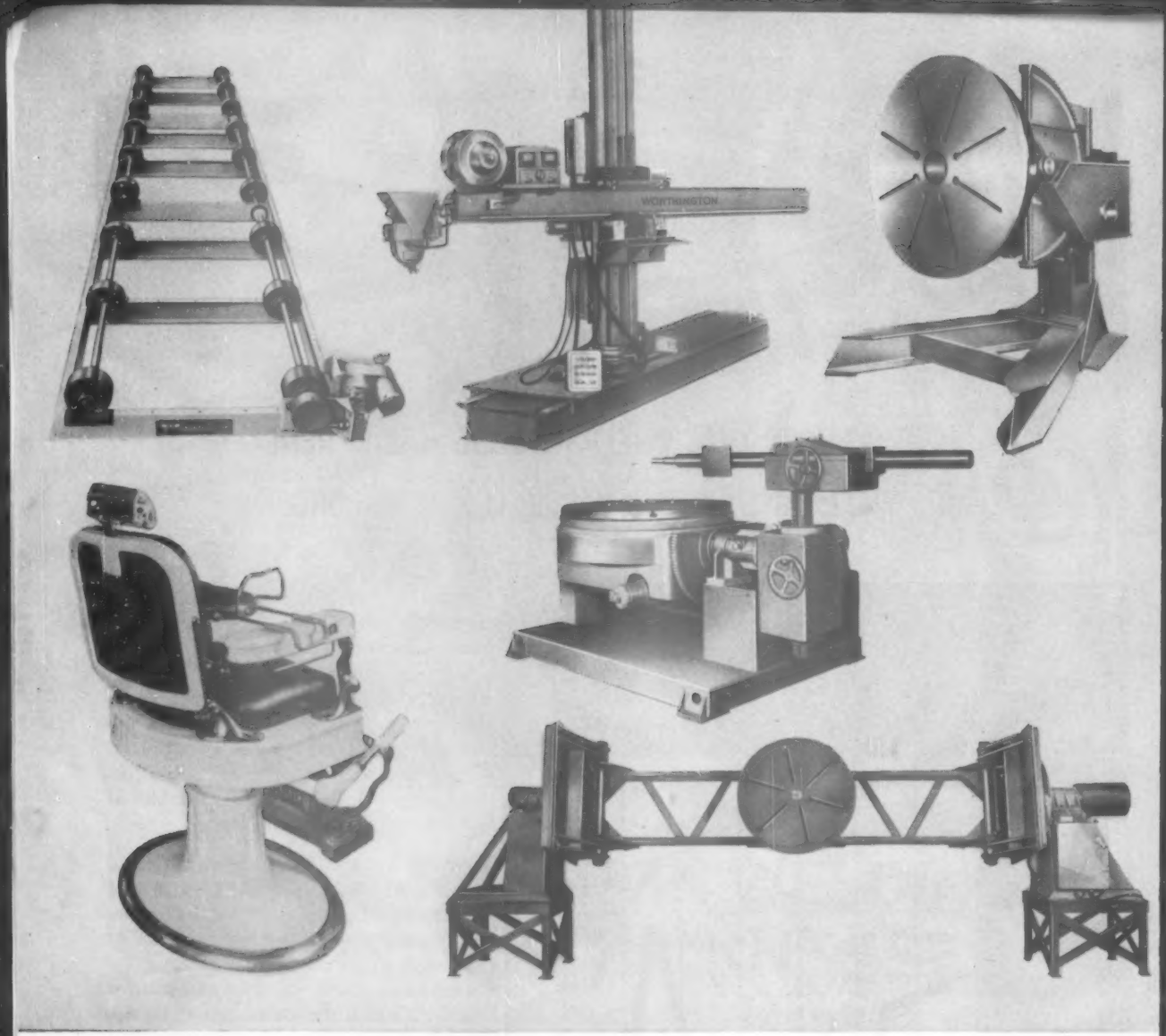
See your authorized Phelps Dodge distributor for Habirprene arc welding cable with the indelible gold markings—the sign of higher quality, longer-lasting cable.

Phelps Dodge also makes a full line of rubber arc welding cable and welding power supply cable. All the above cables are available from stock.

PHELPS DODGE COPPER PRODUCTS

CORPORATION

OFFICES IN PRINCIPAL CITIES



WHICH ONE OF THESE POSITIONERS DOESN'T WORTHINGTON MAKE?

Of course, Worthington doesn't make barber chairs. We really don't know anything about cutting hair . . . *but,* when it comes to positioning for welding, that's where we're right at home.

Whether you're talking about a small positioner for automatic welding of a sub-assembly, a 400-ton turning roll for a nuclear reactor, or a completely integrated push button package, Worthington is ready and able to serve you.

You owe it to yourself to investigate the profit-producing possibilities of positioning equipment—especially in these days of steadily rising labor costs and tight work scheduling. You get faster production, better and smoother welds, fewer accident hazards and less need for crane service. Every piece of Worthington positioning equipment is job-rated for extra capacity, easy installation, greater parts interchangeability and economical operation. And you can count on equally complete Worthington engineering service . . . before you buy, during installation, right through regular maintenance. Why not ask your nearest Worthington distributor or District Sales Office for more information on profitable positioning equipment. Worthington Corporation, Section 55-7, Plainfield, N. J. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON . . . FIRST IN POSITIONING FOR WELDING

WORTHINGTON

See "Tomorrow's Welding Methods Today" at the 1959 Welding Show Worthington Booth No. 235-238.

WELDING ENGINEER

Your April, 1959

Weld World

As WE went to press, these were the industry's latest developments:

. . Russia's "Electroslag" welding process, which has been given widespread coverage in the trade press recently (WE first wrote of it in November, 1957), is now being made available to U. S. industry. "Vertomatic" welding machine will be on display at welding show by Amalgamated Industrial Corp., Philadelphia. (For more details, see new products section.)

. . Anticipating steel strike, most fabricators are stockpiling plate and sheet, as evidenced by March record output. But are they stockpiling welding electrodes and wire to join that steel?

. . Our prediction last month that arc welding accessories would be hiked in price proved correct, although WE didn't expect it so soon. WE foresaw increase of 8-10% by mid-year. One manufacturer raised prices 10% on March 1.

. . Look for Bernard Welding Equipment Co., Chicago, to introduce another new electrode-holder design that completely eliminates overheating and a new concept in low-cost cooling of Mig and Tig equipment. Both products will be seen at welding show.

. . Cambridge Corp., Lowell, Mass., wholly-owned subsidiary of Carrier Corp., is being merged into parent firm as a division to be known as Cambridge Co.

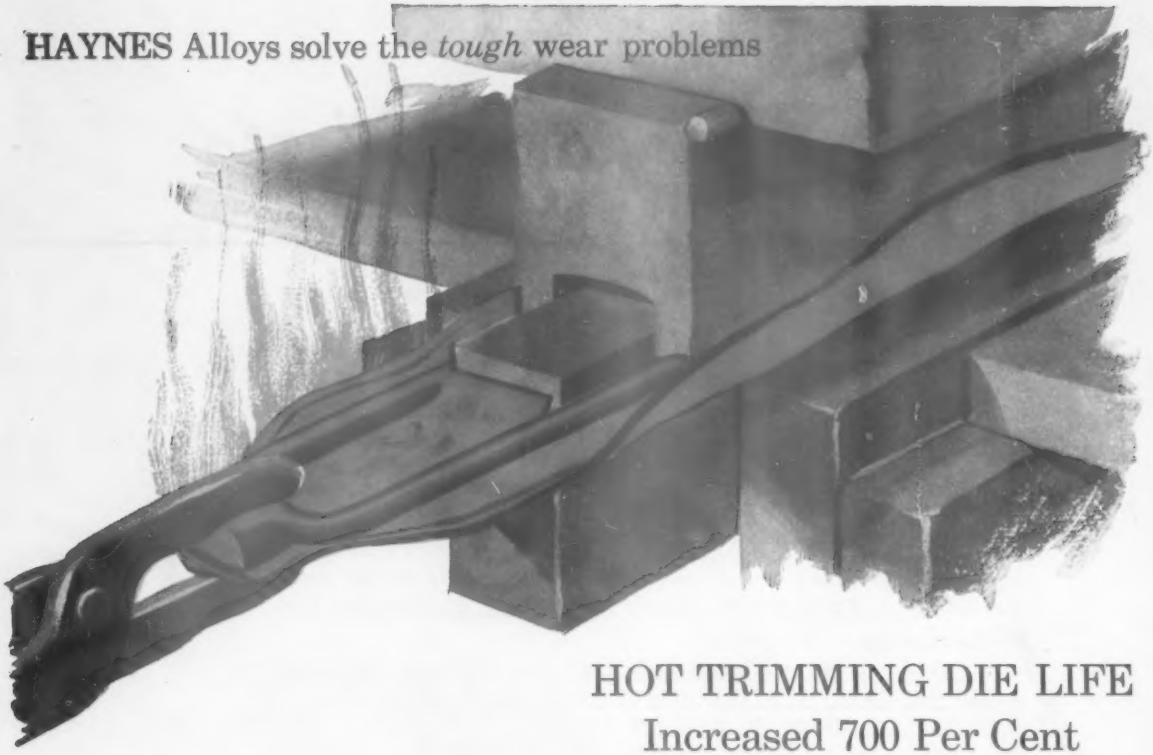
. . Machlett Laboratories, Inc., Springdale, Conn., will become a division of Raytheon Mfg. Co., Waltham, Mass., if merger is approved by stockholders. Directors have already okayed agreement, which would see Machlett, producer of X-ray and other electronic equipment, continue under same name and present management.

. . General Aniline & Film Corp., long held by the Federal government (it was seized during World War II as enemy property), is expected to be sold shortly. Reports indicate that at least 30 groups are interested in purchasing Aniline stock, among them Food Machinery and Chemical Corp., Bell & Howell Co., Minnesota Mining & Mfg. Co. and Sperry-Rand Corp. Ansco, maker of industrial X-ray film, is a division of Aniline.

. . Dual-type recording flowmeter will be marketed shortly by Elematic Equipment Corp., Chicago. Device has built-in mixing chamber for combining two gases, such as helium and argon. Variable control allows manual adjustment of gas proportions which are indicated on one chart.

. . Nelson Stud Welding will introduce new power source at welding show.

HAYNES Alloys solve the *tough* wear problems



HOT TRIMMING DIE LIFE
Increased 700 Per Cent

HAYNES hard-facing alloys resist the sudden shock of impact and the softening effects of heat . . . two characteristics that make them unusually successful in extending the service life of hot-working equipment. In one plant, hot-trimming dies hard-faced with a HAYNES cobalt-base alloy removed the flash from 25,000 parts before they had to be reconditioned. This was a 700 per cent increase in service life over unprotected dies. In this instance the parts were heated to 2000 deg. F just prior to the trimming operation.

If you have a problem involving a combination of heat and impact, straight abrasion, or corrosion, you will find that there is a HAYNES hard-facing alloy that can solve it . . . economically. The hard-facing deposit will increase the service life of the part and, because of its superior wearing qualities, permit you to use a less expensive base material.

Write for literature or call one of our sales offices. HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, Kokomo, Indiana. Sales offices in Chicago, Cleveland, Detroit, Houston, Los Angeles, New York, San Francisco.

This trimmer die, being touched up with a HAYNES nickel-base alloy, has trimmed over 20,000 parts. The hard-facing alloy is tough, machinable, and can be applied to all common die steels by the metallic-arc process.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

The terms "Haynes" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

for critical welding

P&H Combination AC-DC Welders

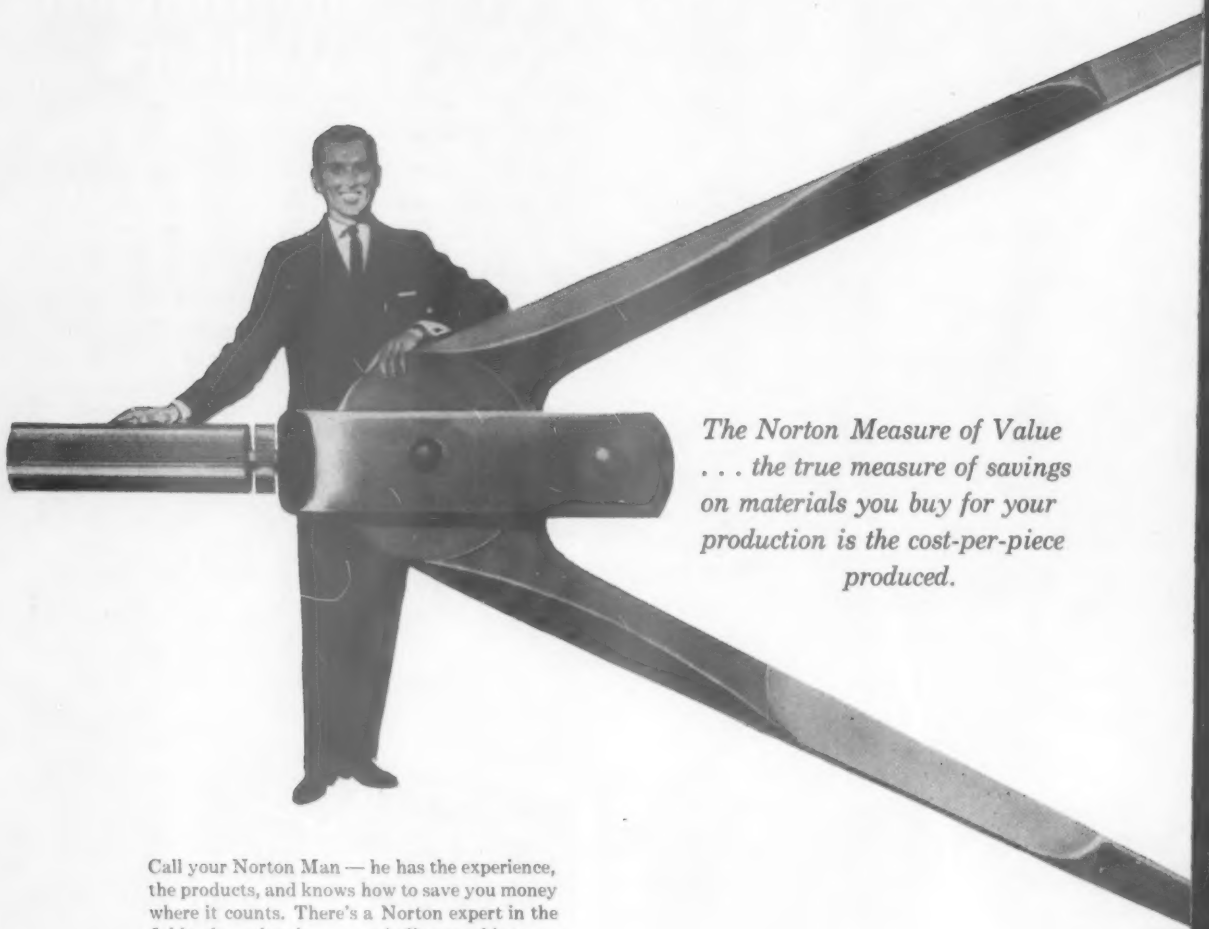
with ON-OFF automatic high frequency

These dual-purpose welders are ideal for super-critical welding because they offer you:

- pre-set gas and water timing
- foot-operated remote heat adjustment and primary contactor control
- high-frequency intensity and phase-shift rheostats
- ON-OFF soft start
- specially built sequence timing for any requirement

Get the complete work- and money-saving story. Write to:

P&H HARNISCHFEGER
WELDERS · ELECTRODES · POSITIONERS
Milwaukee 46, Wisconsin



The Norton Measure of Value . . . the true measure of savings on materials you buy for your production is the cost-per-piece produced.

Call your Norton Man — he has the experience, the products, and knows how to save you money where it counts. There's a Norton expert in the fields of — abrasives . . . grinding machines . . . refractories.

You can produce greater savings than you can buy

The economic truth of the above statement applies to all manufacturing and is especially true in grinding wheels.

There are less expensive grinding wheels than Norton wheels — and on the invoice they may look like a bargain. But if the wheels purchased fail to perform efficiently on the production line or incur production delays because of poor quality or misapplication — a higher cost of production is the price actually paid.

In brief, *the true measure of grinding wheel value is not how much you paid for it — but how much you get from it. Here is what you can get from Norton —*

Norton Company gives you the most advanced research engineering and manufacturing facilities in the entire abrasive field — and you get this great scope of detailed knowledge on a personal basis — your Norton Man.

Your Norton Man starts his career by spending a minimum of 1 year in a carefully planned training course in the Norton plant and a comparable period of training in the field. The Norton Man has an average of 15 years abrasive experience in addition to the specialized training. He is the most knowledgeable man in abrasives that you can consult. He is your consulting abrasive engineer.

He will make a free Abrasive Requirement Study for you. This study lists the correct specifications for each abrasive job in your plant to assure you lowest cost-per-piece produced. He is also available for complete field testing on specific problems.

For example, your Norton Man can increase production by pointing out ways to better wheel usage and fewer wheel changes. He has the widest selection of grinding wheels in the industry to help him select the perfect wheel for new product grinding operations and improving your current grinding jobs — both at the lowest cost. And with Norton grinding wheels you can be sure of precise duplication order after order.

Norton offers true abrasive economy. Economy that pays off in lower cost-per-piece produced. Call your Norton Man. NORTON COMPANY, General Offices, Worcester 6, Massachusetts.

W-1851

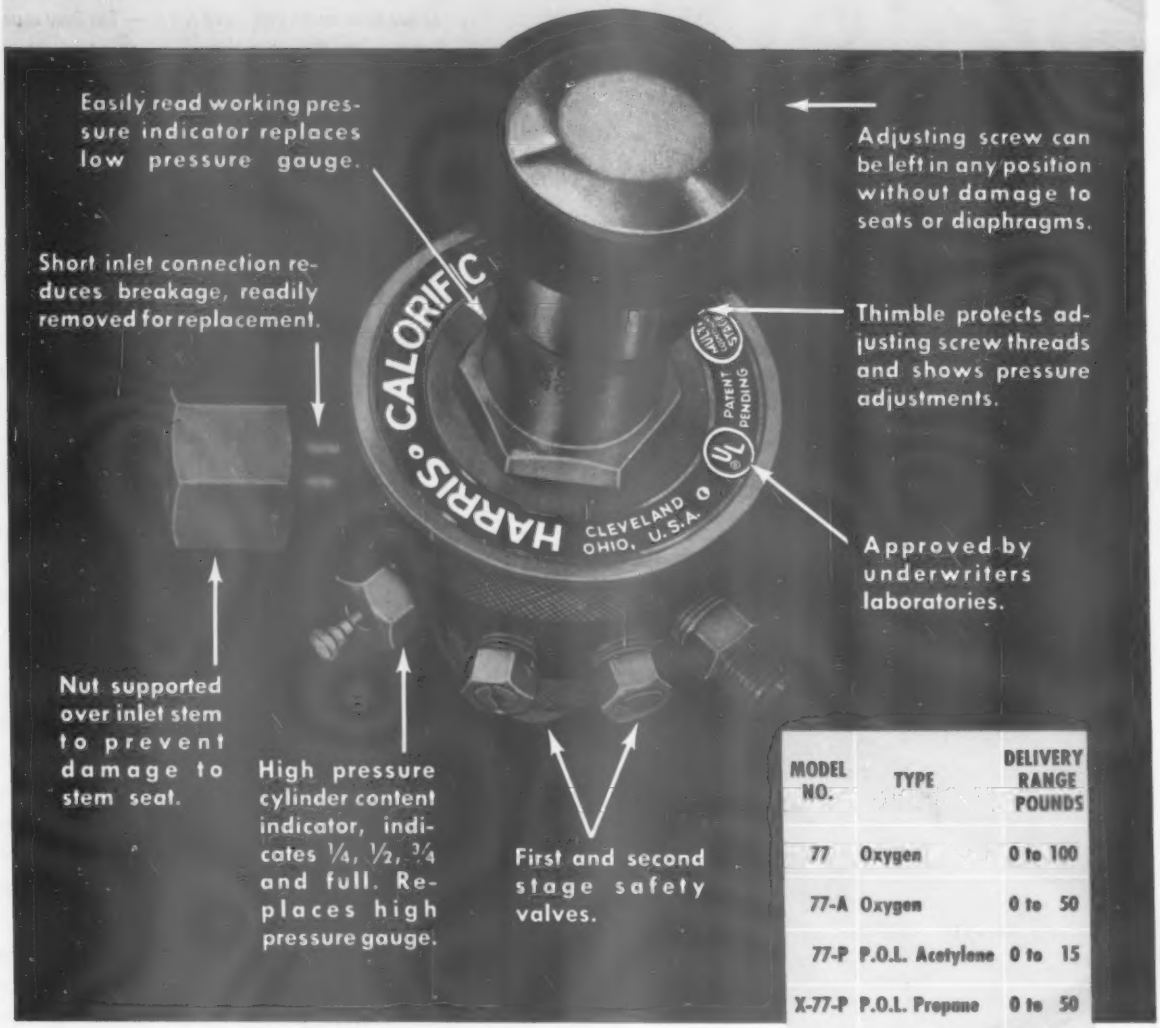
NORTON

ABRASIVES

MAKING BETTER PRODUCTS TO MAKE YOUR PRODUCTS BETTER

RUGGED..DAMAGE PROOF!

HARRIS IMPROVED MULTI-STAGE 77 GAUGELESS REGULATOR


Easily read working pressure indicator replaces low pressure gauge.
Short inlet connection reduces breakage, readily removed for replacement.
Nut supported over inlet stem to prevent damage to stem seat.
High pressure cylinder content indicator, indicates ¼, ½, ¾ and full. Replaces high pressure gauge.
First and second stage safety valves.
Adjusting screw can be left in any position without damage to seats or diaphragms.
Thimble protects adjusting screw threads and shows pressure adjustments.
Approved by underwriters laboratories.
HARRIS CALORIFIC
CLEVELAND OHIO, U.S.A.
PATENT PENDING

MODEL NO.	TYPE	DELIVERY RANGE POUNDS
77	Oxygen	0 to 100
77-A	Oxygen	0 to 50
77-P	P.O.L. Acetylene	0 to 15
X-77-P	P.O.L. Propane	0 to 50
77-D	Coml. Acetylene	0 to 15
X-77-D	Coml. Propane	0 to 50

For more details, see your nearest Harris distributor or write to us.

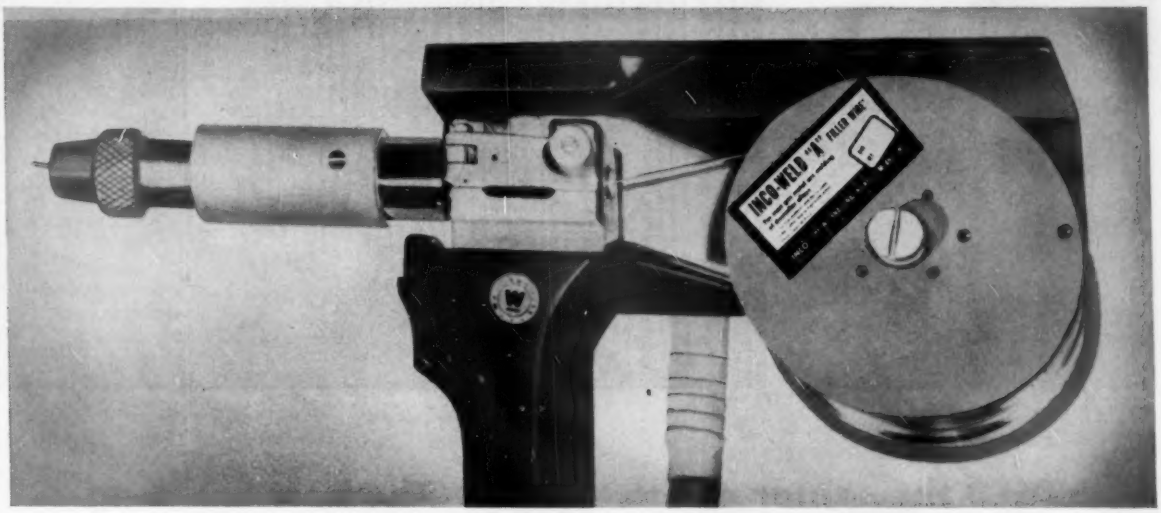
HARRIS

HARRIS CALORIFIC CO.

5501 CASS AVE. • CLEVELAND 2, OHIO

"67" 70/30 COPPER NICKEL FILLER WIRE
INCO-WELD "A" FILLER WIRE
"60" MONEL FILLER WIRE
"61" NICKEL FILLER WIRE
"62" INCONEL FILLER WIRE

Now! Take your pick of filler wires



on Inco's new 2 pound MIG spools

New from Inco, 2 pound MIG spools of:

- Inco-Weld* "A" Filler Wire
- "67"* 70/30 Copper-Nickel Filler Wire
- "62" Inconel* Filler Wire
- "61"* Nickel Filler Wire
- "60" Monel* Filler Wire

Now you can weld most dissimilar alloy combinations, most Inco Nickel Alloys even quicker, even easier. And still get the same sound and strong, corrosion-resisting welds.

Those short-length welds in hard-to-get-at places no longer have to be troublesome. Just load your welding gun with one of these little spools, and you're ready to weld . . . anywhere.

They're another example of how Inco keeps up with your needs, keeps you better equipped to weld better, faster, and easier.

Why not order some of these new spools today from your local distributor? Just look in the classified under "Nickel".

*Registered trademark

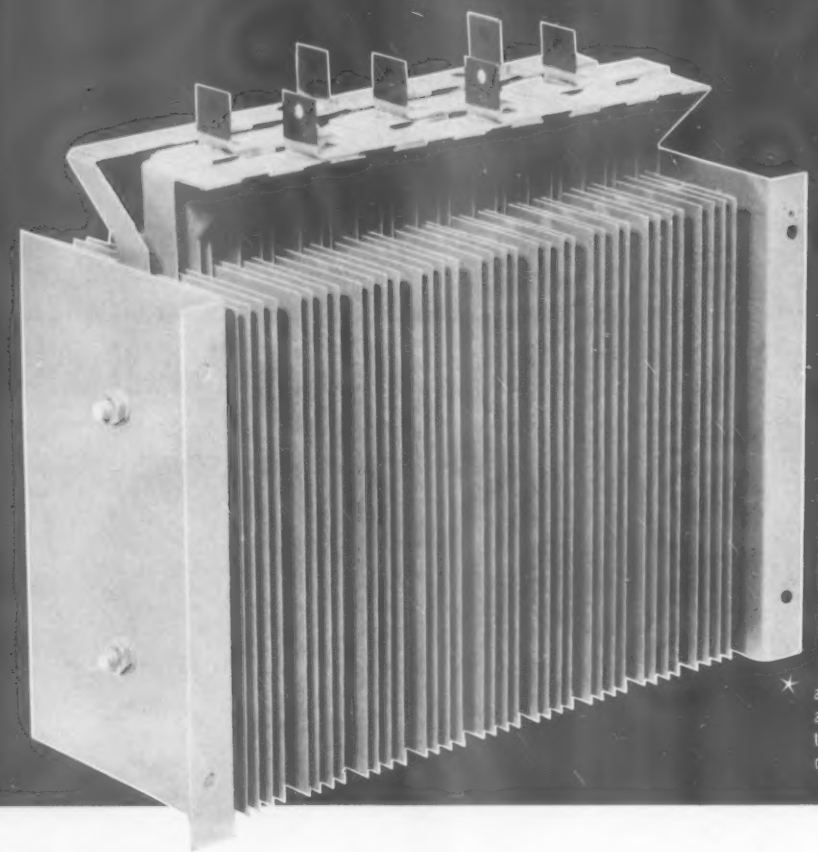
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO

INCO WELDING PRODUCTS

electrodes • wires • fluxes

CYNOSURE ★



★ anything to which attention is strongly turned; a center of attraction.

INDEED the center of attraction — The best and longest lasting rectifier ever placed in a welding machine

The mighty heart of the entire line of MILLER GOLD STAR WELDERS is the rectifier stack illustrated above. A MILLER designed, MILLER built and MILLER guaranteed component — one that has proven itself by establishing unprecedented performance records in the only service in which you are interested — arc welding.

We, too, are interested in no other service. For that reason we have built, tested and retested welders utilizing every available rectifier — and every time the answer is still the stack illustrated above.

And the "secret" why this rectifier stack is superior to other similar devices? SIMPLE — MILLER research directed only to a better and better rectifier FOR WELDING ONLY — MILLER quality production control directed toward a uniformly high standard product — MILLER production techniques involving extensive automation and electronic process regulation — and MILLER "know how" gained as the largest producer of rectifier type welders.

For a more detailed treatment of this subject, you are invited to ask for a free copy of "A New Performance Record in Rectifiers," written by our director of research, G. K. Willecke.

miller WELDERS

miller Electric Manufacturing Company, Inc. APPLETON, WISCONSIN

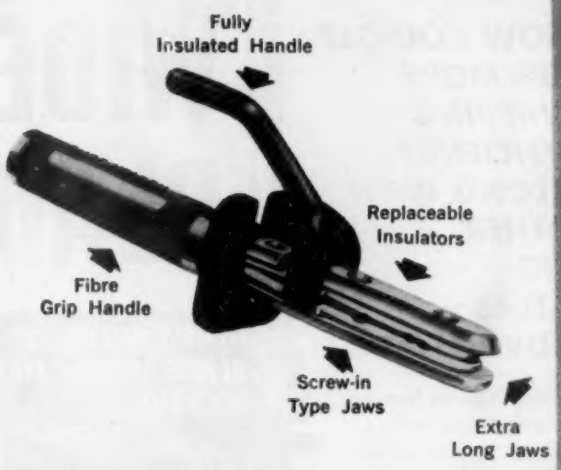
EXPORT OFFICE 250 West 57th St., New York 19, N.Y. ★ Distributed in Canada by Canadian Liquid Air Co., Ltd., Montreal

For 27 Years Preferred By Welders

THE DURO "STANDARD"

- All Parts quickly replaced with a screwdriver
- Screw-in type jaws — No tools required
- Insulated Handle and Guard — Protects operator
- Rugged Fibre Handle — Lasts longer
- Cool Operation — Cool Handling

Featuring "Long Jaw design" for reaching those "hard to get at places"



The New Duro "DUROGON" Tong-Type

THE DUROGON-N3 and N3HD

- All Parts quickly replaced with a screwdriver
- Fully Insulated — Greater safety
- Cool Operation — Cool Handling
- With ALUMINUM Body — Less operator fatigue Mechanical Cable Connection
- With BRONZE Body — For heavy duty operation Mechanical, soldered or brazed connection

"The BEST of this Popular Design!"

DURO

ENGINEERING COMPANY · 31 OREGON AVE. · HAMDEN, CONN.

ATLAS... FIRST AGAIN!

NOW YOU GET 18% MORE CHIPPING EFFICIENCY ALONG WITH OTHER BIG ATLAS ADVANTAGES!

WIDE BLADE

Everybody benefits from an improvement like new "WIDE BLADE," the welder, the owner of the business and even Atlas because new names will be added to the thousands already on our customer list.

Why is Atlas always first with chipping tool innovations? It's simple as this—We are specialists. This is our principal business, not a side line. We are constantly looking for ways to improve weld cleaning techniques—to speed the job and do it better at less cost. Every member of the famous Atlas Line now has "WIDE BLADE," tool

Ask your welding supply dealer to show them to you.

33 MODELS THEY ALL HAVE WIDE BLADES

HERE'S WHAT 18% MORE BLADE WIDTH MEANS TO YOU

This much more weld cleaned in the same amount of time with the same amount of effort.

Sharpen less often. Tools last longer and non-productive time saved.

It's like getting a free tool every time you buy five, because the new wide blades wear longer.

ATLAS WELDING ACCESSORIES INCORPORATED
707 E. LEWISTON
FERNDALE 20, MICH.

Letters . . .

Plasma heat

Sir: *New York City*

We read with interest your article in the February issue concerning plasma heat ("Plasma heat: newest in welding's product lineup," p. 50). We would appreciate any additional information concerning the availability of the plasma arc torches. We would also like to know whether the torches are for sale or for lease.

We recently saw a newspaper announcement that one company has a patented plasma arc torch. What information do you have on the torch or the process?

Frank W. Auld
Frank Roth Co., Inc.

—The names of several companies that are engaged in this type of work have been forwarded.

Rules

Sir: *Rock Island, Ill.*

I think your editorial in the February issue of *Welding Engineer* is very good. I will see to it that all our weldors read it.

R. L. Custer
International Harvester Co.

Once again, rules

Sir: *Dallas*

We read your February editorial, "Once again—rules," with a great deal of interest. We know that ". . . poor management and supervision" does exist.

Charles E. Squibb
Welders Supply Inc.

—Reprints have been supplied to the above correspondents at their request.

Explosive welding

Sir: *Columbus*

The January, 1959, issue of *Welding Engineer* contains a brief reference to explosive welding. (WW, p. 13.) We would appreciate any additional information and references available on the process and stages of development.

J. J. Vagi
Battelle Memorial Institute

—See article on explosive welding on page 61 of this issue.

It's wonderful!

Sir: *Springfield, Pa.*

You have a wonderful magazine which I enjoy reading and which provides me with a lot of good information.

B. F. Scott

WHO'S KIDDIN' WHO, MISTER?

A photocell tracer that automatically adjusts for kerf width?
A cutting machine that can handle any cutting area? No matter how wide or how long?
I'll believe it when I see it.

All right, don't believe it. Stop at the Linde Company Booth (No. 300) at the AWS Show, Chicago Stockyard Auditorium, April 7-9, 1959. You'll see 'em both . . . in action! Remember, that's Booth No. 300.

LINDE COMPANY, *Division of Union Carbide Corporation*
30 East 42nd Street, New York 17, N. Y.
In Canada: Linde Company, Division of
Union Carbide Canada Limited, Toronto

Linde Trade-Mark

UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

Do YOUR welding helmets help produce more and better welding?

YES!...they do if they're Fibre-Metal's

FIBERGLAS* WELDING HELMETS

Undeniable comfort, clearest wide vision and assured safety are basic quality features of these Fiberglas welding helmets. FIBRE-METAL compression-molded, Fiberglas-reinforced polyester resin shells offer the very finest in durable face protection. Proper glass fiber distribution and a "beaded edge for strength" insure long-lasting, trouble-free helmet life. Shells are self-extinguishing, are unaffected by heat and moisture, will not warp or lose shape, may be easily and quickly cleaned and sterilized. *Welders TELL US these helmets help produce more and better welding!*

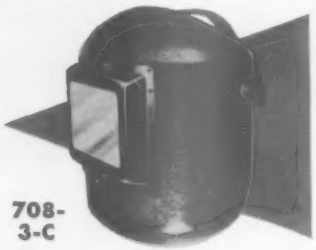
All helmets have Ratchet Adjustment "free floating" Headgear, impact resistant adjustable friction joints and adjustable chin rest. Glassholders are available in plastic, steel or Dowmetal, in either fixed or lift-front styles. All types of helmets are described in Catalog No. 26.

Ask your Welding & Safety Distributor!

*OWENS-CORNING TRADE MARK

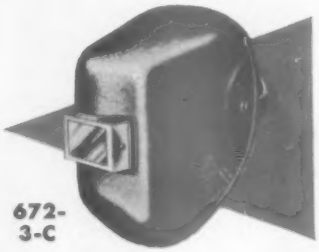
702-3-C

This is a popular standard-size Helmet that offers excellent fume and light seal with extra ventilation. Has all the famous Fibre-Metal comfort features. Offers variety of fixed and lift-front glassholders.



708-3-C

Over 120% increased vision with its 4½" x 5¼" lens... more vision both vertically and horizontally. Reduces eyestrain and fatigue. Excellent for welders who must wear bifocals, or trifocals, while welding.



672-3-C

The popular narrow-front shell for compact, lightweight protection. Best for welding in tight spots... eliminates flat, spatter-collecting surfaces. Less pitting, lasts longer. 674-3-C has lift-front glassholder.

606-3-C

Features extended neck and chest protection with greater ventilation. Standard-size shell. Also available with an Inner Bib *(See our Catalog No. 26)* for extra fume and light seal.

The FIBRE-METAL Products Company | CHESTER PENNA.

In CANADA: Fibre-Metal (Canada) Limited, Toronto

See us at the WELDING SHOW—Booth 434—Chicago

30 YEARS AGO

(Taken from the WELDING ENGINEER of April, 1929)

—30 YEARS AGO—

C. H. Dockson Co. has moved to 40-42 W. Milwaukee Ave., Detroit.

—30 YEARS AGO—

Thirty-eight municipalities in the west and south now have sections in their building codes allowing electric welding in construction.

—30 YEARS AGO—

The recent annual meeting of the American Welding Society, at New York City, included papers by J. H. Deppeler, Metal & Thermit Corp., and T. McClean Jasper, A. O. Smith Corp. F. T. Llewellyn, president of AWS, presided over the meeting.

—30 YEARS AGO—

The Cleveland Welding School is moving to 2261 E. 14th St.

—30 YEARS AGO—

Lincoln Electric Co.'s welding school is doubling its facilities due to the large number of applicants for the six-week course.

—30 YEARS AGO—

Stoody Co., Whittier, Calif., has purchased, and is preparing to mine and refine, a tungsten deposit in Arizona.

—30 YEARS AGO—

J. F. Lincoln, former vice president of Lincoln Electric Co., Cleveland, has been named president of the company.

—30 YEARS AGO—

Deutsche Werke shipyards, Kiel, Germany, recently completed two oil tank barges which were almost entirely welded.

—30 YEARS AGO—

American Fusion Electric Corp., Chicago, maker of seam and spot welders, will construct an addition to its plant at 2610 Diversey Ave.

—30 YEARS AGO—

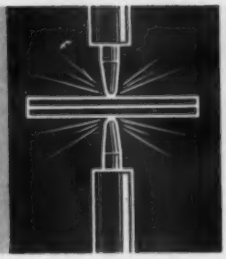
Harry G. Masten Co., Chicago, has been named a distributor of Una welding machines and welding wire.

P R MALLORY & CO Inc

MALLORY MEMOS

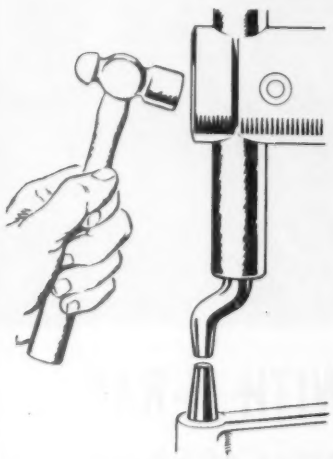
NEWS AND TIPS ON RESISTANCE WELDING

P. R. Mallory & Co. Inc., Indianapolis 6, Indiana



WELDING HINTS

Use enough cooling water . . . at least 1½ gallons per minute through each tip; pays off in longer tip life, stronger welds. (Mallory fluted hole electrodes give you extra cooling and extra life . . . without extra cost.)



Don't use a steel hammer to knock welder arms into alignment. Avoid damage by using a rawhide or rubber mallet.

Send for this handy wall chart of "Do's and Don'ts" for your shop.

Make 1001 Welding Set-ups with MALLORY Holder Components

One of the best time-savers you can have in your resistance welding tool crib is a kit of the new Mallory interchangeable holder components. In a matter of seconds, you can put together the holder you need for hundreds of set-ups that you may have considered special. Changeovers can be completed in minimum time by anyone who can handle a wrench. And the holder inventory you need is only a fraction of what you would otherwise need to carry.

Holders: ejector, or non-ejector; made of several high strength Mallory alloys.

Barrel: choose from four diameters, several standard lengths, and a number of tapers and threads.

Adapters: a variety of straight and angle designs increases flexibility of Mallory holders.

Ask your local Mallory welding distributor to show you how interchangeable holders can save you time and money. He'll be glad to help you select the components best suited for your shop.

Mallory welding products are available from authorized distributors located in all principal cities.

PRO GETS NEW LOOK AT WELDS WITH X-RAY

Learns to use portable Baltospot in a matter of hours

SO COULD YOU! There's no mystery about taking your own weld X-rays. You or your men can learn to make good radiographs in less than a day—with Baltospot portable X-ray equipment.

There are only three simple steps:

1—Measure thickness of part and refer to chart

2—Make exposure

3—Develop film according to chart

Nothing could be simpler. It's a terrific cost-cutter, too (77 percent savings on inspection costs were recently reported by a prominent tank fabricator). And a real incentive for maintaining good weld quality—keeps the occasional faulty weld from becoming a costly repetitive fault.

Your Westinghouse X-ray representative has the whole cost-saving story on Baltospot portable X-ray equipment. Or write: Westinghouse X-ray Department, 2519 Wilkens Avenue, Baltimore 3, Maryland. J-08377

YOU CAN BE SURE...IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

BETWEEN PASSES

engineering center

A recent communication from the American Welding Society tells us that plans to build the new United Engineering Center in New York City are well advanced. More than $7,672,000 of the necessary $10 million is already available or pledged. The headquarters for the principal engineering societies will be built on a block-long site facing the United Nations Plaza.

The 20-story tower will symbolize engineering's importance and provide tangible benefits in improving efficiency of the closely related headquarters staffs of the groups occupying the Center.

The AWS joins the five founder societies—American Society of Civil Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Institute of Chemical Engineers—and about 15 others in sponsoring this project.

Irish campanology

The dictionary gives this definition for campanology: *The science of bells; art of ringing bells.* But what has all this to do with welding?

WE recently received a letter from a reader in Ballynahinch, County Down, Northern Ireland. Our correspondent: C. J. Robb, Consultant: Preservation of Old Churches, Mansions, Theatres, Military Monuments and Curios. Mr. Robb wrote:

"The art of the weldor has come into its own in one phase of metal surgery—that of repairing old church bells. To the antiquarian campanologist, this method of dealing with cracked or broken bells is now welcomed everywhere, though some responsible authorities still favor recasting. The physical properties of bell metal, which is cast by a high temperature process, lend themselves to welding—as the metallurgist well knows. The weldor, however, must be expert in this operation of fusion and the correct application of heat. Many bells in Great Britain and Ireland have been restored to perfect condition and returned to musical notation by the means of welding. The great advantages, apart from the antiquarian interest, are the perfect restoration of the old world tone and the only-fractional cost involved."

Depicted here are "before" and "after" views of the bell of Bag-

dad. Submitted with his letter by Mr. Robb, they give "good example of what can be done by the skilled weldor." He then asked us, "Have many bells been welded in America?" Since welding in campanology has not come to our attention recently, maybe some of our readers would be better equipped to answer Mr. Robb.

home study course

The Metals Engineering Institute of American Society for Metals has added "Arc Welding" to its home study curriculum. The course is designed for welding technicians and production, sales and managerial personnel with the industry.

Editor and coordinator of the subject matter, which was contributed by 15 welding authorities, was Clarence Jackson of Linde Co.'s Newark laboratory. "Arc Welding" covers all forms of the process. Subjects in the home-study and in-plant training course include such fundamentals as weldability, power supply and equipment, consumable and non-consumable electrodes, mechanical properties, design and quality control. Techniques are also taught, as well as applications in steels and various non-ferrous materials.

More information on the course may be obtained from: Metals Engineering Institute, American Society for Metals, 7301 Euclid Ave., Dept. NR-3, Cleveland 3, Ohio.

welded rail, but . . .

Not for use by trains. In this age of missile and rockets, welded rail has found a new application. A missile development center in New Mexico has a 35,000-ft stretch of such track. And perhaps no length of steel rail is more perfectly aligned. The New Mexico "railroad" track has to be—it supports missile vehicles traveling at nearly five times the speed of sound.

The 39-ft length, 171-lb steel sections used were aligned with gages reading to within one thousandth of an inch. (Because any temperature variations would invalidate instrument measurements, the master rail, to which the two operational rails were fixed, was aligned at night.) In assembly line fashion, rails were cut, welded and normalized, and the welds sheared and ground. The welding operation required that the rail ends be hydraulically brought together with a force of 49,000 lb.

The alignment's precision was demonstrated recently when a test vehicle sped across it at 2,853 mph, believed to be the fastest a device has ever traveled on the earth's surface.

20,000 leagues

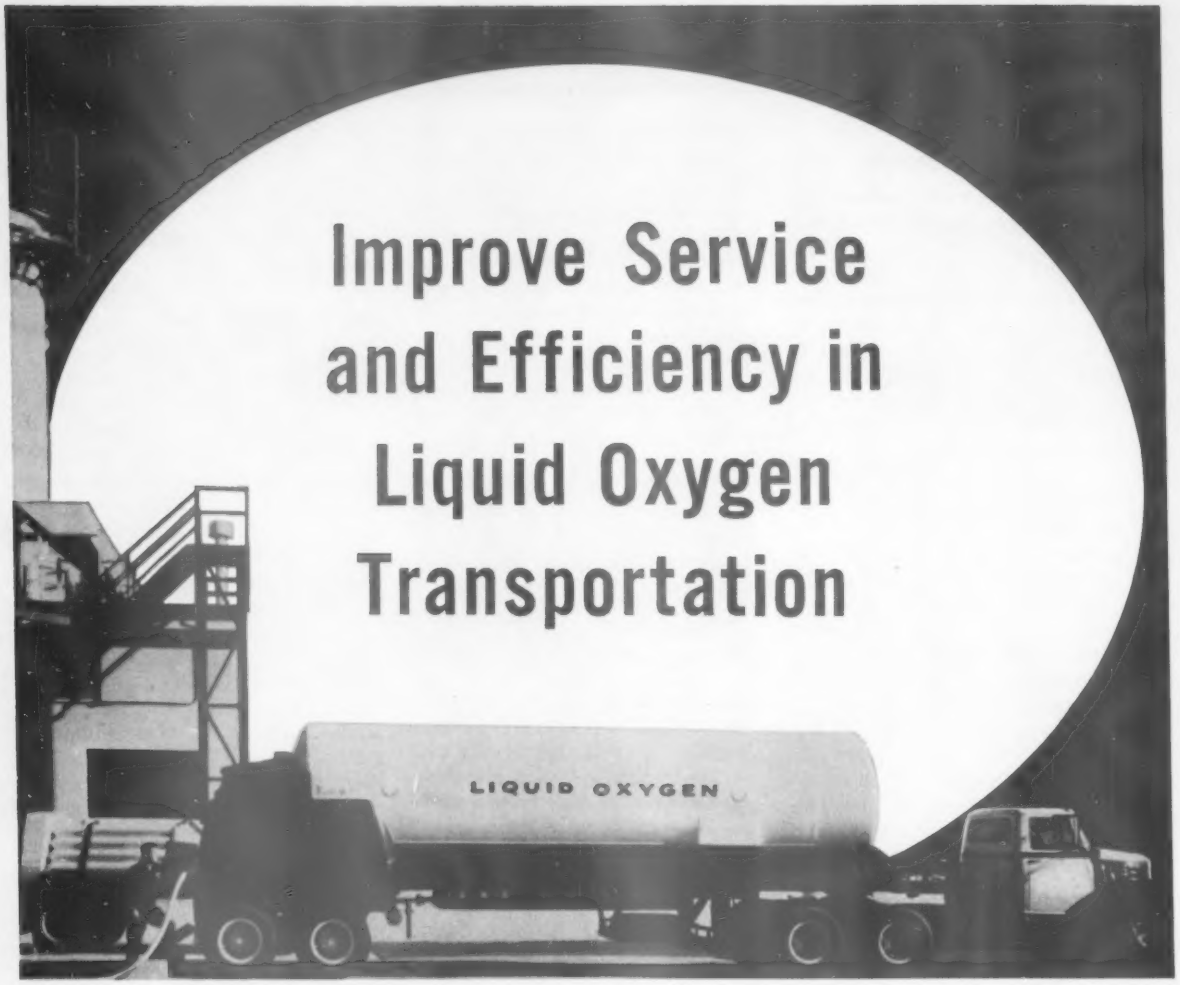
Shades of Jules Verne . . . again. First it was the *Nautilus*, the world's first nuclear submarine, followed by sister ships. Now it's the *Aluminaut*.

The *Aluminaut* is the name of a proposed submarine to be fabricated from aluminum. Its designer, Reynolds Metals Co., says it will be capable of descending more than three miles and of touching more than 60% of the ocean floor.

Anyone wish to wager on the method of construction?

Visit WELDING ENGINEER's Booth 915, Welding Show, Chicago, April 7-9.

Improve Service and Efficiency in Liquid Oxygen Transportation



This is a Cambridge Liqua-Guard Semi-Trailer Model 4100L used for transporting liquid oxygen. It uses a Cambridge vacuum jacketed aluminum vessel and features light weight and high payload. It comes complete with Cambridge medium pressure pump.

...with Cambridge Liqua-Guard Products

Cambridge "liquid logistics" offers today's most modern concept for transporting and distributing atmospheric gases.

- Far greater product volume vs. weight ratios — one semi-trailer transports equivalent of 18 truckloads carrying 100 standard cylinders each!
- Minimizes personnel and physical damage hazards.
- Reduces labor and releases storage and yard space.
- Less frequent delivery, ample gas supply always available.

Many gas manufacturers are now taking advantage of this modern "liquid concept" with Cambridge Liqua-Guard Semi-Trailers and Delivery Trucks. They are part of the complete Liqua-Guard System which gives atmospheric gas users improved efficiency and service by storing, transporting and distributing in liquid form.

The Cambridge Liqua-Guard System for Liquefied Atmospheric Gases features a complete line of vacuum jacketed vessels, vaporizers and associated equipment. Send for Bulletin CS19 today.

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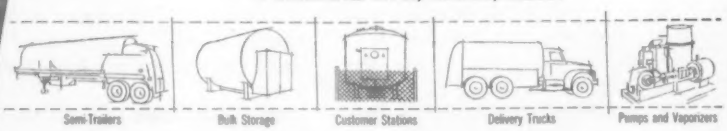

CC9-3

Blueweld STABILIZER

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Insures Low-Hydrogen Welds Against Defects Caused by Moisture-Laden Shielding

- Keeps Low Hydrogen Electrodes *Truly Low Hydrogen.*
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Immediate Shipment on D.O. Rated Orders
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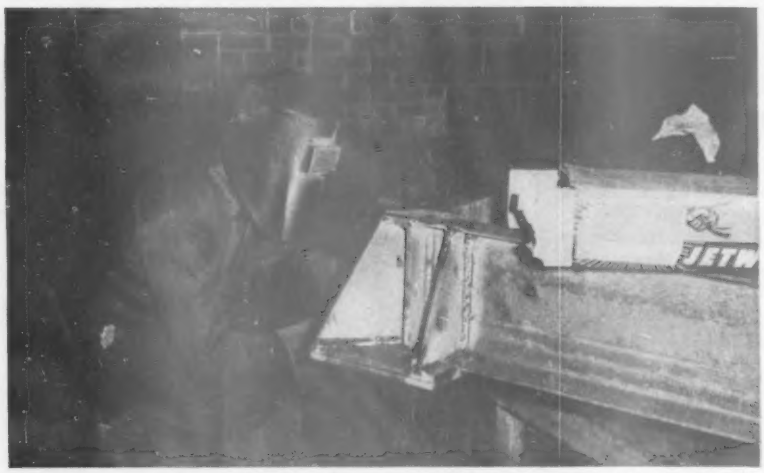
Lincoln

WELDYNAMICS

NEWS ABOUT ARC WELDING AT WORK CUTTING COSTS

AEROGLIDE TRIMS WELDING COSTS 1/3 ...IMPROVES PRODUCT QUALITY



Structural parts are welded faster and easier with Jetweld.

Like many other manufacturers, Aeroglide Corporation of Raleigh, North Carolina, found themselves caught in a price-cost squeeze last year.

Aeroglide is one of the largest manufacturers of produce handling equipment and grain driers. All the equipment they build is welded and much of the welding is on sheet metal. Their biggest cost problem involved the sheet metal welds. Burn-through and spatter were eating up shop time and profits.

John Wyatt, Aeroglide's Shop Superintendent, "Our whole shop is more efficient because of improved welding methods."

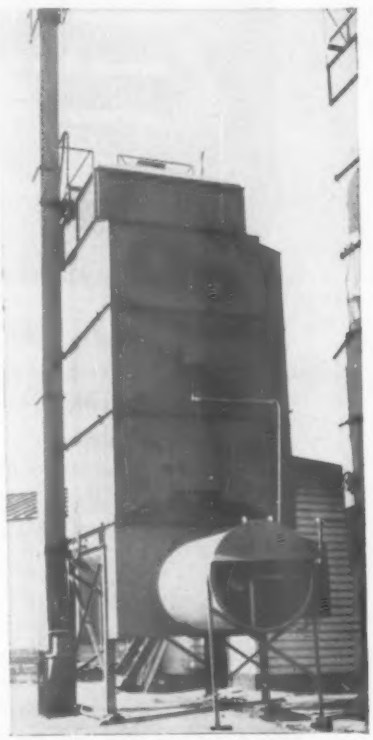
John P. Wyatt, Jr., Aeroglide's shop superintendent and James F. Kelly, President, decided to seek outside help. They invited Kirk Sterling, a welding engineer with Lincoln's Charlotte, N.C. office to help them make a survey of Aeroglide's welding operations.

Working closely with Mr. Wyatt, Sterling made a careful analysis of their welding jobs. The burn-through and cleaning problems were solved with a switch to Fleetweld 37 electrodes which are specially designed for sheet metal welds. Greater production efficiency on heavier structural members was achieved with iron-powder Jetweld electrodes.

Mr. Sterling also conducted a five-day welding clinic which was voluntarily attended by Aeroglide's weldors and shop supervisors. Higher shop efficiency resulted from a better understanding of welding procedures as a result of the clinic.

The total effect—a 33% cut in welding costs.

Jim Kelly, Aeroglide's youthful president, commented, "The Lincoln people have done us a great service. Big industries can go to their suppliers and demand the products they need. Companies like ours depend on our suppliers to show us how to get the most out of what's available. Lincoln has helped us build a better product . . . and made a stronger Lincoln customer.



Aeroglide grain dryers, easier to assemble, sturdier and more efficient with welded construction.

The LINCOLN ELECTRIC CO.
Dept. 1753, Cleveland 17, Ohio
The World's Largest Manufacturer of Arc Welding Equipment

APRIL, 1959

Welding Engineer

ESTABLISHEED 1916

Fifteen years later

THIS IS AN IMPORTANT MONTH for welding. Not only is it National Welded Products Month, but it is also Welding Show month.

How things have changed since 1944. Fifteen years ago, this department, in an editorial entitled "Should we stand alone?", asked if a separate welding show was possible. At the time, the idea was generally scoffed at, condemned or ridiculed. But a few daring individuals with vision carried the idea through, and the Welding Show was born.

From a modest beginning in Houston only six years ago, the AWS Show has grown to be one of the 25 largest exhibits in the country.

Every year since its inception, the Show has grown—grown because welding has grown. Thus far this year, each issue of WELDING ENGINEER has announced at least one new joining process. And the end is not in sight.

Exhibits at this month's show in Chicago will provide a glimpse into welding's future. Right now these glimpses may seem to be pure fantasy. But how far away is nuclear welding? How quickly will man harness nuclear energy to make possible a perfect bond between such diverse materials as wood and high-alloy steel, or wood and glass?

The future of welding is unlimited . . . the only limitation one might cite is man's own ignorance.

No other industry offers the challenge, the opportunities or the future that welding does. We are fortunate to be part of an industry celebrating an important month.

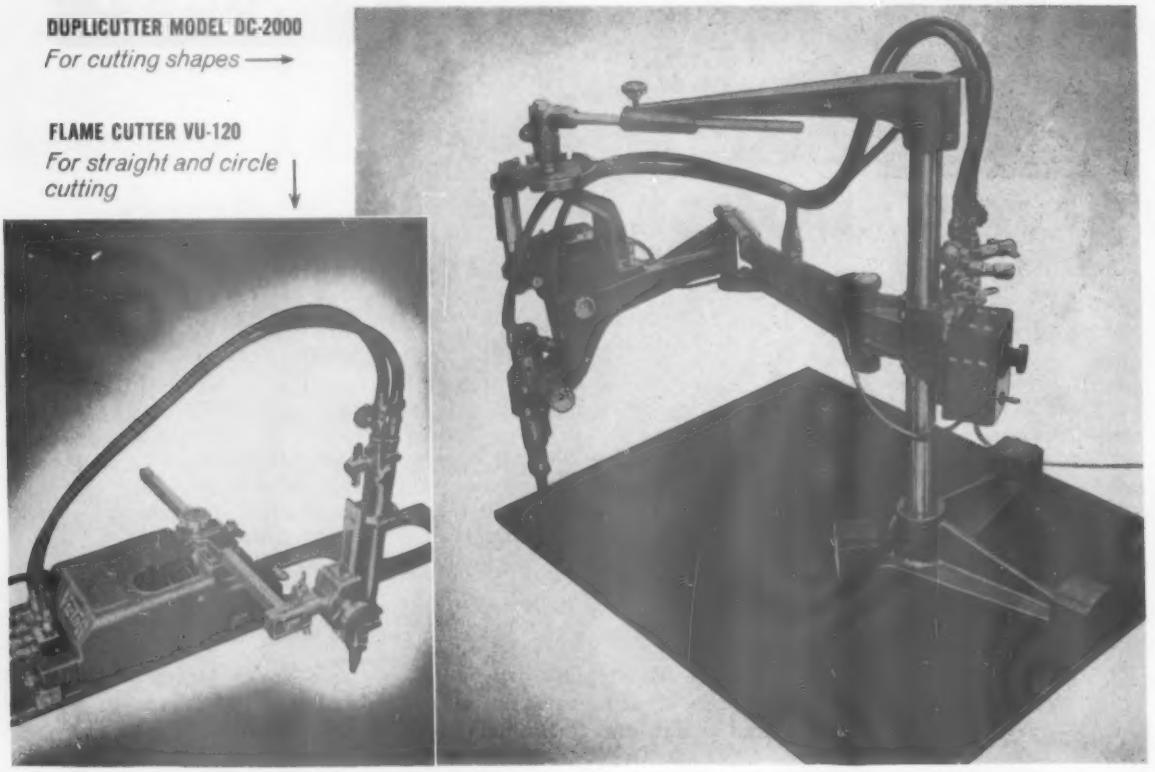
Let's make the most of it.

SPEED YOUR PRODUCTION

with these Victor Cost-Cutters

DUPLICUTTER MODEL DC-2000
For cutting shapes →

FLAME CUTTER VU-120
For straight and circle cutting ↓



Victor Duplicutter, Model DC-2000

- Duplicates shapes up to 19½" diameter circles, 12" x 35" rectangles.
- Holds tolerances of plus or minus 1/64" in 2" steel.
- Templates easily changed, making practical both long runs or a single copy.
- Weight, 36 lbs. — easily carried.
- Magnetized feet set on stock being cut — no levelling needed.
- Uses Victor cutting tips thru size 5.

Victor Flame Cutter, Model VU-120

- Cuts straight lines, square or bevel kerfs, circles to 96" diameter.
- Adaptable to submerged or inert arc automatic welding.
- Travels 0 to 180" per minute forward or reverse; variable speed transmission provides full power over entire range.
- Free-wheeling neutral for easy positioning.
- Accommodates both 2 and 3-hose torches, with or without gear rack.
- Second torch holder available for parallel cutting.

To see how Victor Cutting Machines can speed your production, ask your Victor dealer for a demonstration . . . or write us for descriptive Bulletin 353.

Profitable dealerships open in a few areas; inquire now.

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Mfrs. of welding & cutting equipment; high pressure and large volume gas regulators; hardfacing rods, blasting nozzles; cobalt & tungsten castings; straightline and shape cutting machines.

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J. C. Menzies & Co., Wholly-Owned Subsidiary

National Welded

Products Month

Welding Engineer

REMEMBER SEPTEMBER? It was National Welded Products Month during 1958.

April will receive all the laurels this year, and WELDING ENGINEER is proud—proud that this annual recognition of a deserving industry was initiated through our efforts.

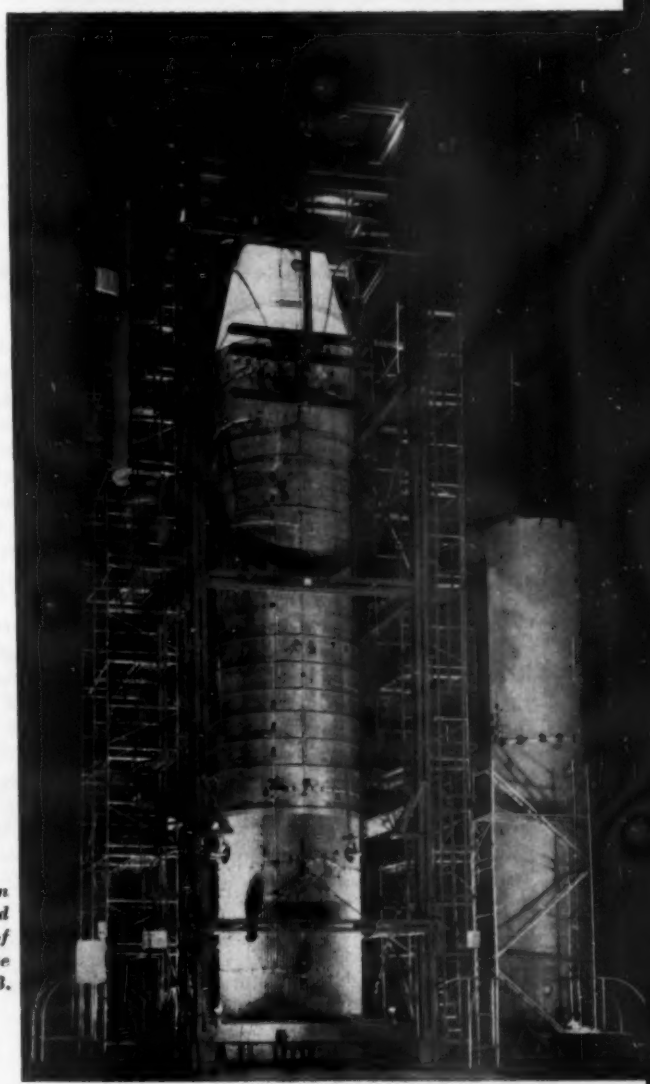
In truth, our slogan this month should read "Remember Welding—12 months a year."

From your wedding band to the Jupiter missile on this page, welding had an important part in their creation.

Whether you're looking for reduced weight, economy or just good looks in your product, the common denominator is welding.

Like a good friend who is always there when needed, welding should not be forgotten at any time.

September, April or August—remember welding.



The Jupiter intermediate range ballistic missile shown cradled in a 60-ft tower behind the Chrysler-operated Michigan Ordnance Missile plant is another example of welding's wide application. For details on this and the Redstone missile, see the article on pages 42 and 43.

SHERMAN Hotel, headquarters for 40th Annual National Spring Meeting of the American Welding Society, April 6 to 10.

In Chicago—

AWS expects 15,000 persons at Seventh Annual Welding Show

CHICAGO WILL BE the welding center of the world during the week of April 6 when it plays host to the American Welding Society's 40th Annual National Welding Meeting and Seventh Annual Welding Show.

During the meeting, which is being held in conjunction with the American Institute of Electrical Engineers' Electric Welding Conference, more than 65 papers will be presented by representatives of United States, Canadian, British and French industry. Headquarters for the meeting is the Hotel Sherman.

"The science of arc welding," this year's Adams Lecture, will be presented Monday morning by Clarence Jackson, Linde Co. Preceding the lecture will be an address by AWS President G. O. Hoglund, who will preside over the business session which officially opens the meeting.

During the remainder of the week, papers will be given on nuclear power equipment, ultrasonic welding, welded structures, aluminum alloys, stainless steels, titanium and zirconium, as well as arc and resistance welding and brazing.

"Welding for high-temperature aircraft service," will be presented by P. Gordon Parks, Solar Aircraft Co., as this year's Educational Lecture series. The lecture will be given in two parts, on the afternoons of Monday, April 6, and Tuesday, April 7.

As usual, the President's reception will be part of the festivities. It will be held Monday evening. Other highlights of the meeting program include the annual banquet following the reception, the Ohio State University Student Alumni dinner on Tuesday evening, and the Resistance Welding Manufacturers Association luncheon on Wednesday.

Registrants will have an opportunity to meet the Society's newly elected president, C. I. MacGuffie of Air Reduction Sales Co., Union, N. J., who takes office June 1.

Other recently elected officers who will be present are first vice president, R. D. Thomas, Jr., Arcos Corp., Philadelphia, and A. F. Chouinard, National Cylinder Gas Div., Chemetron Corp., Chicago.

Recently chosen directors-at-large are Jay Bland, General Electric Co., Schenectady, N. Y.; F. G. Singleton, Singleton Welding Supply, Kansas City, Mo.; C. B. Smith, Douglas Aircraft Co., Long Beach; and J. R. Stitt, R. C. Mahon Co., Detroit.

Elected at the same time were the following district directors: G. W. Kirkley, General Dynamics Corp., Groton, Conn. (Dist. 1); J. W. Kehoe, Westinghouse Electric Corp., Pittsburgh (Dist. 3); H. E. Schultz, General Electric Co., Evendale, O., (Dist. 5); L. L. Baugh, Allis-Chalmers Mfg. Co., Springfield, Ill., (Dist. 7); C. L. Moss III, Wyatt Metal & Boiler Works, Dallas (Dist. 9); C. B. Robinson, Air Reduction Pacific Co., San Francisco (Dist. 11).

To add variety to the meeting, arrangements have been made for a tour on Wednesday of the Dresden Nuclear Power Station constructed for Commonwealth Edison Co. in Grundy County, Ill. Many types of welding were used in fabrication of the station. The 190-ft-wide containment vessel alone required over 17,000 ft of welds.

Tentative plans have been made to also tour, on Thursday, the Superheater Div. of Combustion Engineering Inc., and the electrode plant of Champion Rivet Co.

You Can See These Exhibitors at the Show

Acetogen Gas Co.	701	Glendale Optical Co., Inc.		Philips Electronics Inc.	208
Air Reduction Sales Co.	521	Goss Gas Inc.	117	C. E. Phillips & Co.	605
Alloy Rods Co.	530	Handy & Harman	204	Picker X-Ray Corp.	233
All-State Welding Alloys Co., Inc.	610	Harnischfeger Corp.	425	Precision Welder & Flexopress Corp.	807
Aluminum Co. of America	421	Harris Calorific Co.	120	Pure Carbonic Co.	511
Amalgamated Industrial Corp.	625	Hobart Bros. Co.	601	J. M. Ragle Industries	911
American Manganese Steel Div.	412	Robt. W. Hoffman Co., Inc.	633	Reid Avery Co.	507
American Messer Co.	336	Robert Holmes & Bros. Inc.	609	Robotron Corp.	520
American Platinum & Silver Div.	422	Independent Engineering Co.	332	Robvon Backing Ring Co.	901
American Pullmax Co., Inc.	200	International Nickel Co.	323	Sellstrom Mfg. Co.	301
Ampco Metal Inc.	904	Jackson Products	516	Sight Feed Generator Co.	433
Arcair Co.	906	KSM Products Inc.	320	Simonds Abrasive Co.	311
Arcos Corp.	523	Kaiser Aluminum Inc.	733	Singer Glove Mfg. Co.	126
Aronson Machine Co.	221	Kedman Co.	803	A. O. Smith Corp.	122
Aro Spot Welder Div.	525	Kennametal Inc.	430	Smith Welding Equipment Corp.	712
Balteau Electric Corp.	226	Lenco Inc.	903	Sperry Products Inc.	225
Banner Welder Inc.	309	Lewis Welding & Engineering Corp.	431	Square D Co.	232
The Berkeley Co.	723	Lincoln Electric Co.	411	Steffan Mfg. Corp.	130
Bernard Welding Equipment Co.	600	Linde Co.	300-305	Stoody Co.	316
Brennan, Bucci & Weber Inc.	700	McKay Co.	321	Storch Products Co., Inc.	800
Budd Co.	315	Magnaflux Corp.	103	Sylvania Electric Products Inc.	907
Cambridge Corp.	408	Marquette Mfg. Co., Inc.	914	Taylor-Winfield Corp.	512
Cam-Lok Div.	217	Metal Removal Co.	317	Tec Torch Co., Inc.	220
Cayuga Machine & Fabricating Co.	436	Metal & Thermit Corp.	614	Tempil Corp.	613
Champion Rivet Co.	910	Metallizing Co. of America	804	Tweco Products Inc.	622
Contour Marker Corp.	234	Mid-States Welder Mfg. Co.	629	Uniflex Cable Div.	634
Coyne Cylinder Co.	912	Miller Electric Mfg. Co., Inc.	623	Unique Equipment Inc.	604
Dockson Corp.	908	Milwaukee Electric Tools Co.	900	United Wire & Supply Co.	526
Emerson Electric Mfg. Co.	121	Modern Engineering Co.	334	Vacuum Tube Products Co., Inc.	325
Eutectic Welding Alloys Corp.	500	National Cylinder Gas	730	Victor Equipment Co.	620
Exomet Inc.	715	National Torch Tip Co.	617	The Webb Corp.	917
Fenway Machine Co.	326	Nelson Stud Welding Div.	211	Welding Alloy Mfg. Co.	903-A
Fibre-Metal Products Co.	434	Ohio Nut & Bolt Co.	700-A	WELDING ENGINEER	915
F & N Metal Products Inc.	504	OXO Equipment Co.	216	Martin Wells Inc.	333
Frommelt Industries	805	Page Steel & Wire Div.	533	Weltronic Co.	721
Liquid Carbonic Div.	621	Pandjiris Weldment Co.	400	Westinghouse Electric Corp.	100
General Electric Co.	802	Cecil C. Peck Co.	920	Worthington Corp.	

Tuesday at noon, president-elect MacGuffie will officially open the Welding Show at the International Amphitheatre when he flame-cuts a chain stretched across the opening to the exhibits.

The show will run from April 7 to 9. Hours will be 12 noon to 10 p.m. Tuesday, 10 a.m. to 10 p.m. Wednesday, and 10 a.m. to 6 p.m. Thursday.

Some 15,000 persons are expected to visit the booths of more than 110 manufacturers who will present products and exhibits with the theme of the show, "Production," in mind.

One exhibit that should draw crowds is that of Amalgamated Industrial Corp., Philadelphia, who will show the European-constructed Electroslag welding machine. The Vertomatic machine, using the Electroslag process developed in Russia, permits the welding of plates 1-in. thick, and upwards, in a single pass in the vertical position. Though the process has been given much publicity in the trade press in recent months, it was first mentioned in WELDING ENGINEER in November, 1957.

A taste of the extraordinary future that is ahead for the world—and the universe—will be presented by A. O. Smith Corp., Milwaukee. It will show models of products that look as if they were taken from the set of a Hollywood science fiction movie.

One of the products is Stellerweld, a self-contained welder powered by nuclear reactions. Another unit is the Vega, a portable anti-gravitational welder able to float at a predetermined level in the air alongside the weldor, and pulled about with ease as he moves from location to location.

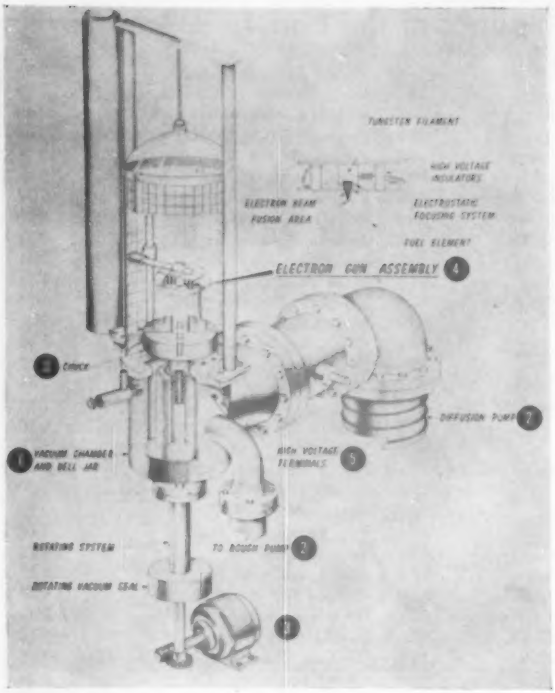
Other futuristic welding equipment to be shown include a cosmic-ray powered welder, a self-contained hand gun, and an air-conditioned helmet.

A special ladies program has been planned for the week, so don't leave the women home. Sunday evening, April 5, a get acquainted social will be held. Each morning a continental breakfast will start off a day filled with such activities as card and theater parties, and sightseeing tours and luncheons.

Chicago's many night-spots, featuring talent prominent in the entertainment field, will provide Society members and their wives many hours of evening enjoyment. If the legitimate theater is what you like, many popular stage dramas and musicals will be playing.

Restaurants specializing in the cuisine of other countries will offer after-theater eating variety.

APRIL is National Welded Products Month, as proclaimed by President Eisenhower. Though originated by WELDING ENGINEER last September, AWS now sponsors it.



ELECTRON beam vacuum welding unit is capable of welding highly reactive materials with ease while reducing contamination and producing quality welds.

by **W. I. Steinkamp** and **W. L. Wyman**

General Electric Co.

- Less contamination
- Better weld quality
- Reduced costs

A nuclear age process . . .

Electron beam welding—a new development for industry

BECAUSE OF THE HIGHLY reactive metals and alloys being used for nuclear components, inert-gas welding has seen extensive development in the past few years. However, some limitations of the process were ever-present.

Fabrication of these components demanded three improvements: minimization of weld contamination by reactive gases, better weld quality, and reduced costs. A nuclear-age welding process was the answer—electron beam welding.

The new process causes fusion welding in a localized area by bombardment of parts with a beam of high-energy electrons. The entire operation is done in a vacuum chamber. (See *WeldWorld;* WELDING ENGINEER, Oct., p. 13.)

When a spiral tungsten filament is heated above 2,600 K, a large number of electrons are emitted from the filament surface. The electrons must be concentrated into a beam with a small spot-focus, and given directional velocity.

When the beam strikes the parts to be welded, kinetic energy of the electrons is converted to heat—and melting and fusion result. (Kinetic energy per electron is equal to $\frac{1}{2}$ mv^2 where m is electron mass and v is velocity.) Welding energy can be changed by varying either the number of electrons in the beam, or electron velocity.

Since velocity is a function of the potential between the electron gun and the work pieces, electron velocity increases as voltage increases. Filament heat, voltage, space charge, distance between the gun and work pieces, all contribute to changing the current or number of electrons striking the work pieces.

By moving the parts to be welded at a suitable speed under the beam, a continuous weld can be made.

The welding chamber is first evacuated with a rough pump which lowers pressure to 25 microns in one minute. A diffusion pump reduces the chamber pressure even more, down to one micron.

At this pressure the atmosphere has been reduced by a factor of 99.9999%. Contamination in this atmosphere, as compared to atmospheric air, is one part per million.

As mentioned above, a high-purity tungsten filament when heated above 2,600 K will discharge 6×10^{18} electrons per second for each square centimeter of its surface. (A pure tungsten filament is used rather than the more efficient thoriated or oxide-coated filaments because of known damage to these latter types.)

Electrons are accelerated by a potential of several thousand volts. Within the available power limits, the best operating range is 6,000 to 10,000 volts. Lowest voltage used to date is 1,800; highest available voltage is 10,000.

While being accelerated, the elec-

trons are also focused into a beam. The most suitable spot diameter for welding ranges from 1/32 to ⅛ in. Because the heat can be concentrated in a very narrow region, thin materials are easily welded; heavier sections, however, need a larger spot.

When the combination of voltage and current (varying from 20 watts for foil to 1,000 watts for ⅛-in.-thick material) is high enough, sufficient heat for welding is produced.

When welding any nuclear fuel elements, purity of the atmosphere surrounding the molten metal must always be considered. Normal pressure used with electron beam welding removes 99.999987% of the air in the system. As a result, a highly-reactive metal such as zirconium can be welded with no increase in oxygen or nitrogen content, and a sizeable reduction in hydrogen content.

Inert-gas shielding problems, *e.g.*, water vapor in the shield, inert-gas trapped in the puddle, air in the shielding gas, turbulence, and erratic arc action, are eliminated.

In electron beam welding, three factors insure essential elimination of contamination: the electron beam is non-reactive; any gas resulting from the molten metal is carried off by the vacuum system; and most foreign particles are ionized into positive particles attracted to the gun and away from the weld area.

One other advantage should be mentioned: the harsh starts common to other welding processes are not encountered because of the smooth heat buildup to the material melting point.

Within the restrictions of time, available equipment and special techniques required, electron beam welding has been applied principally to fabrication of nuclear fuel elements using Zircaloy-2, aluminum and stainless steel.

Initial work on Zircaloy-2 determined that procedures generally acceptable for Tig welding could be used satisfactorily on butt, edge, plug and cap welds.

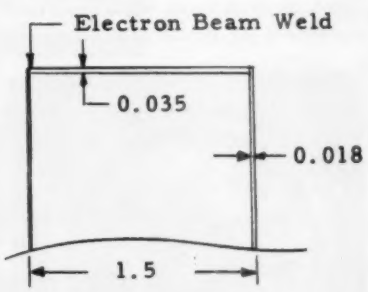
Mechanical properties (see table) were evaluated and showed tensile strength to be approximately 10% lower than the annealed parent metal (an average of 21 tests on 0.026-in. material). Yield strength increased markedly and approached tensile strength.

The anticipated decrease in duc-

Mechanical properties of Zircaloy-2 as welded versus annealed parent metal

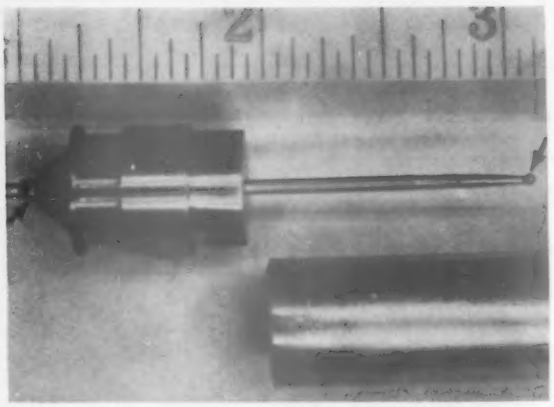
Specimen—in.	Tensile strength 1000 psi	Yield Strength (0.2% offset) 1000 psi	Area reduction %
0.020 thick parent metal	63.8	46.6	44.8
0.020 thick all weld	52.4	50.0	20.6
0.020 thick all weld	50.9	45.6	25.0
0.020 thick all weld	53.5	48.1	19.0
0.030 thick parent metal	47.8	42.8	48
0.030 thick parent metal	47.2	43.2	50
0.030 thick all weld	61.8	58.2	43
0.060 thick parent metal	60.8	50.0	47
0.060 thick parent metal	57.0	44.3	47
0.060 thick all weld	57.4	54.0	36.4

SOME mechanical properties of Zircaloy-2 were evaluated and results are shown in this table. Comparison is between as-welded specimens and the parent metal.



JOINT DESIGN

FUEL element end-cap of Zircaloy-2 was welded with the new process. Photo at far left shows the as-welded component in actual size. Center drawing illustrates the joint design, while the photo on the far right is a microsection of the weld area.



STAINLESS steel thermocouple was welded to a stainless end-cap by the electron beam process. Thermocouple sheath at point of attachment is a 0.060-in.-diameter, 0.010-in. wall tube.

tility was verified in the reduction of area measurements. On the whole, weldments of Zircaloy-2 behaved in much the same way as conventional metals converted from a rolled to a cast structure as a result of fusion welding.

Corrosion rate when exposed to high-temperature water is one of the first considerations for any Zircaloy-2 weld. Because of the loss of corrosion resistance when heated in an oxygen and nitrogen-containing atmosphere, a series of autoclave tests were made to determine water corrosion properties.

Specimens were placed in a static de-ionized water autoclave operating at 686 F and 3,000 psi. They were checked and weighed after 10 days, and then every 30 days after the first inspection.

Test results indicated corrosion resistance of the weld and heat-affected zone to be as good as or better than the parent metal. White corrosion products were detectable on the surface of 0.020-in. specimens after 4,266 hours, or approximately 177 days. The 0.030 and 0.060-in. specimens are still in test.

Gas analysis exhibited no increase in oxygen or nitrogen content in the weld specimens within the limits of the test's accuracy. (Limits are ± 20% for oxygen and nitrogen and 10% for hydrogen. As was expected, hydrogen content was reduced.)

Although stainless steel can be Tig welded with relative ease, certain applications are better done with electron beam welding, especially when joining thin to heavy sections.

Other applications include closure of vessels without the problem of internal gas-pressure buildup, which often causes weld blow holes when sealing with conventional welding processes. Mechanical properties (ductility, tensile strength) are the same as annealed base metal.

Development of electron beam welding of aluminum has been directed toward nuclear fuel-element closure requirements. These include: (*1*) fuel elements braze-bonded with a eutectic aluminum-silicon alloy, then fusion welded across the brazed joint, (2) Al-Si bonded, internally and externally cooled elements, (*3*) unbonded natural uranium elements, (*4*) uranium oxide elements, (*5*) aluminum alloy core elements, and (*6*) hot pressed elements.

Each of these applications compared favorably with conventional methods of closing, and in some cases, electron beam welding offered a solution to problems encountered when welding aluminum with conventional methods, *e.g.*, elimination of "blowouts" in the weld area when closing unbounded elements.

In general, other metals currently in use can be satisfactorily welded with the electron beam process, with the possible exception of chromium and magnesium which have high-vapor pressure at melting point.

Extensive work has not been done to determine mechanical properties of these other materials, however, superficial inspection indicates they are excellent (except for molybdenum and tungsten where further study is needed).

Welding cost is another important factor in electron beam welding. The only direct operating cost when using this process, other than labor, is electricity.

When 1,080 aluminum or stainless components were welded, cost totalled $1.13 for a 24-hour period. Tig welding the same components would cost $6.67. For materials such as zirconium or other reactive metals, electron beam welding costs remain the same, while the cost of Tig welding increase to about $35 for the 1,080 elements.

This new process is the answer to contamination, weld quality and cost when fabricating nuclear fuel elements.

* * *

The work of the following individuals is acknowledged: I. M. Brickey, general assistance; R. H. Todd and Ruth B. Ely, metallography; R. A. Thiede, corrosion tests; L. J. Chockie and the Physical Metallurgy Group, mechanical testing; J. L. Hascall, photography; and Dr. S. H. Bush, review and suggestion.

TYPICAL weld and microsection of weld made on an unbonded aluminum fuel element is shown above. Consistent high quality and clean porosity-free welds can be made on this type.

Color, texture

high-strength–and

it's weldable . . .

Vinyl-coated steel sheet introduced to industry

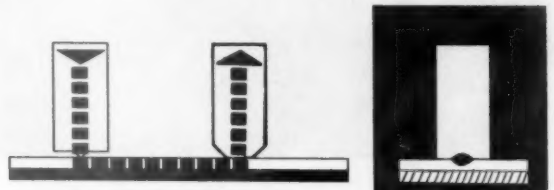


Figure 1

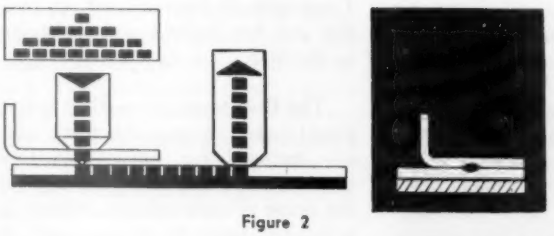


Figure 2

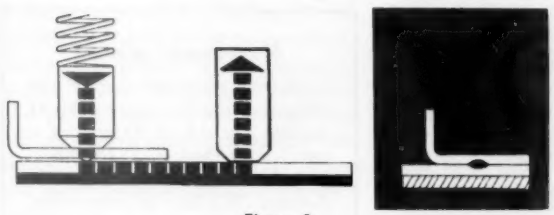


Figure 3

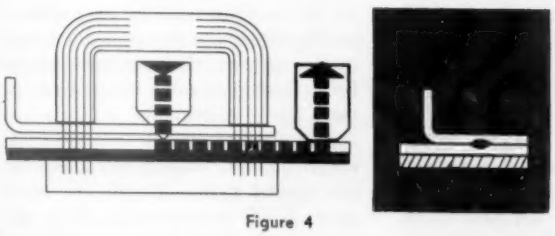


Figure 4

FOUR welding techniques for joining the new vinyl-coated steel sheet have been successful. Depicted in the drawings above, they are (figures 1 through 4 respectively): Graham stud welding; projection welding with a capacitor discharge; spring-loaded electrode welding; and magnetic force welding.

PLASTICS AND STEEL sheet have been combined successfully to create a versatile product with applications ranging from railroad car and living room fixtures, to desk accessories and picnic coolers.

The new material, which is weldable, is produced by United States Steel Corp. and is known as vinyl-coated steel sheet.

In developing this material, company researchers boiled, bent, scratched and stain-tested samples of the plastic-coated steel sheet. The results—a "till death do us part" marriage.

The liquid vinyl can be applied in coatings ranging from 0.008 to 0.020 in. thick, and may be specified in increments of 0.001 in. within this range. Steel sheets are available in gages from 18 through 28. Widths range from 24 to 52 in.; lengths from 30 to 144 in.

In manufacturing the vinyl-coated steel, cold-rolled or galvanized sheets in coils are first fed into a cleaning unit. The strip is then given an electrochemical treatment where slight surface etching occurs and a small chemical deposit is made.

In the next step the sheet is roller-coated with a thin film of thermosetting adhesive. A second roller applies a suitable primer material to the reverse side as a corrosion protective.

The two coatings are cured simultaneously in an oven, then the vinyl coating is applied by a reverse roller. After heat-curing the plastic, a permanent bond results.

While still hot, the steel strip passes through embossing rolls which impress a selected texture into the vinyl. After cooling, the product is either coiled or cut into lengths.

Extensive tests by the company show the coated steel can be sheared, slit, punched, lock-seamed, stamped, drawn or roll-formed without damage to the coating or change in color. Elongation of 30% is possible.

In joining the new metal, however, spot welding operations normally used on this thin-gage steel must be modified. Vinyl is a good insulator, so the current flow must be controlled indirectly, *i.e.*, from the back side of the sheet.

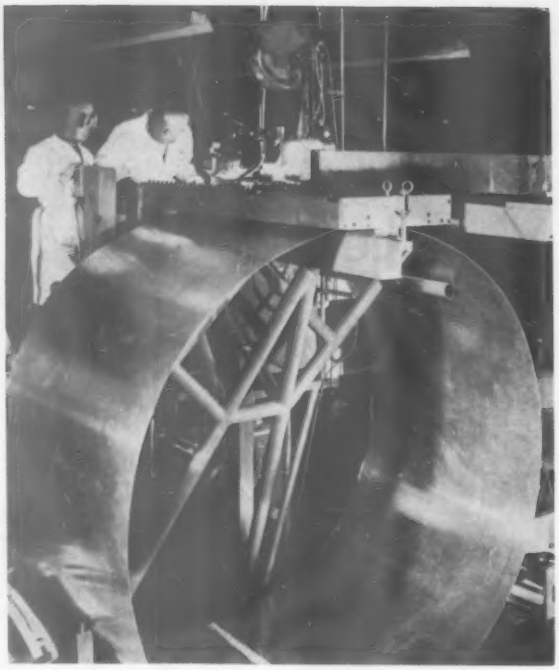
Four welding techniques have been applied successfully by the company: Graham stud welding; projection welding with a capacitor discharge; spring-loaded electrode welding; and magnetic force welding. (See figures 1 through 4.) Variations of these four techniques have produced high-standard welds.

Most of the other fastening methods usually employed on thin-gage steel sheet can also be used.

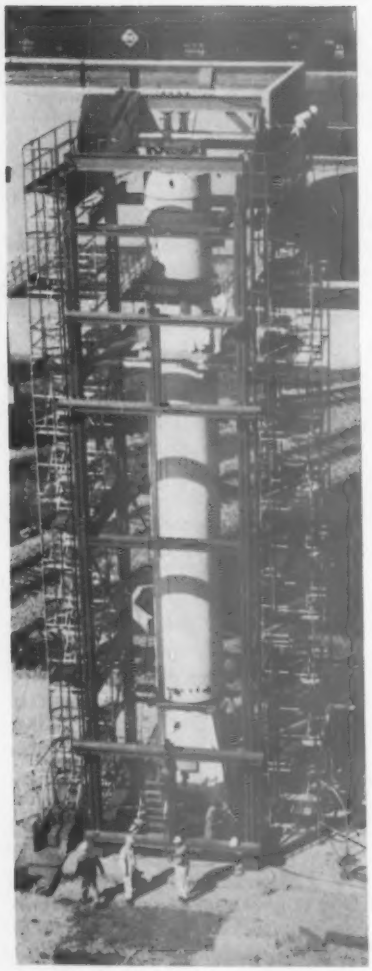
Under testing conditions, the coated steel showed good physical properties. (The material can stand up under continuous 160 F temperatures, for two days under 212 F. At 350 F it will soften, and at 400 F it will char. It is not combustible, however.) Resistance to scuff, abrasion and stain is excellent, according to the company.

Since the new product has color, texture and steel's high strength, as well as good physical properties, U. S. Steel says manufacturers will have greater opportunity to express beauty in their products.

Army's Redstone and Jupiter missiles are on target



TANK section of Jupiter missile is fabricated by Mig welding. Extraordinary precautions are taken to insure quality of welds in aluminum alloy. Such quality control has resulted in most successful of nation's missiles.



REDSTONE ballistic missile shell is readied for simulated flight test back of Michigan Ordnance Missile plant near Detroit. Tower, 60-ft high, enables engineers to test shell structure for effect of actual flight loads.

LONG ACCUSTOMED to important roles, welding is lending vital assistance to one of the nation's newest industries—missile fabrication.

At a government-owned plant in Sterling Township, Mich., near Detroit, Army Jupiter and Redstone missiles are being produced on an assembly-line basis by Chrysler Corp. The company's Missile Division operates the facility.

If the United States is indeed lagging in the missile and rocket field as some experts aver, you wouldn't know it from the appearance of this new kind of industrial plant with its strange machinery and eerie electronic sounds.

All but the most highly classified areas of the site were recently opened to the press. Open to inspection were:

¶ Parallel Jupiter and Redstone assembly lines where as many as 300,000 parts are combined to form a single missile.

¶ Elaborate test installations that put missiles through simulated launchings and flights duplicating conditions of pressure, wind force, thrust, heat, vibration and climatic conditions.

¶ Intricate inspection procedures and equipment, including unique applications of X-ray, to insure that missiles produced meet the one acceptable standard of quality—perfection.

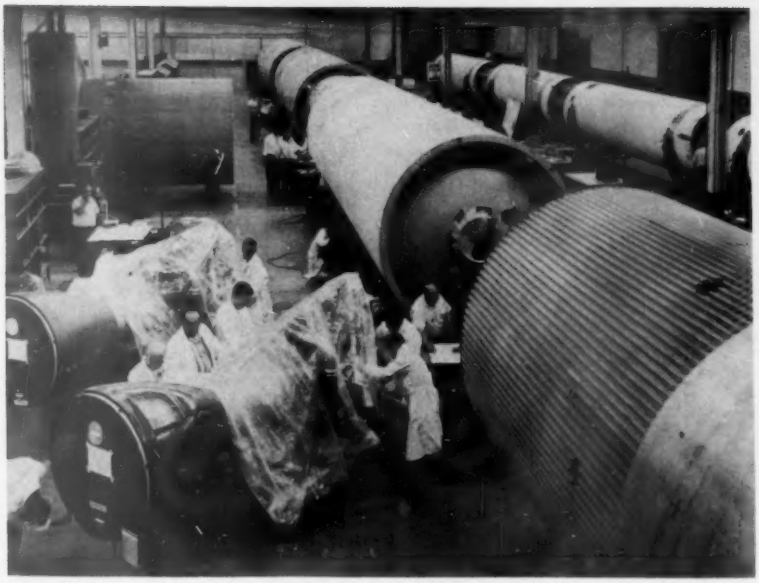
¶ Production of ground support equipment—miniature Cape Canaverals on wheels, used by Army and Air Force units to transport, set up, fuel, test and fire Jupiters and Redstones in the field.

The Redstone is a medium range, liquid-fueled supersonic ballistic missile intended for surface-to-surface use against ground targets far beyond the range of conventional artillery. It is approximately 63 ft long and 5 ft 10 in. in diameter and uses alcohol and liquid oxygen as a propellant, and hydrogen peroxide to generate steam for operation of some internal equipment.

The Jupiter is an intermediate range ballistic missile designed for use against ground targets at ranges up to 1,500 nautical miles. It is approximately 60 ft in length and 105 in. in diameter. A kerosene-base fuel and liquid oxygen combine to provide the propellant and to generate power for some internal operating systems.

Man-made planet

Shortly after this article was prepared, the five-stage Juno II missile (of which Jupiter is a part) launched a 13-lb, gold-plated satellite into outer space. Pioneer IV is now in solar orbit.



ASSEMBLY-line employees move Jupiter engines (left foreground) into position for installation into missile's booster section during final assembly operations. Jupiter's booster section is also used as first stage of Army's Juno II moon rocket series. In right background is Redstone assembly line.

The Redstone is composed of three parts which can be assembled in the field immediately prior to launching. These are a power plant unit, a fuel tank unit, and a warhead and control unit. The Jupiter has but two parts—the thrust unit, containing rocket engine and fuel tanks, and the warhead unit, containing either nuclear or conventional warheads and fuzing systems.

Chrysler missile engineers employ a foolproof method of testing the reliability of welded joints in missile shells. By means of a lightweight portable X-ray unit suspended within the 58-ft aluminum shell of the Jupiter, engineers can ascertain the perfection of each section weld before the shells are subjected to hydrostatic stress tests.

Results of the X-rays are imprinted on strips of film wrapped around the exterior of the missile shell wherever welds have been made. An accurate radiograph of the welded section is then studied to determine weld quality.

In welding aluminum alloy, inert-gas processes are used. Under unfavorable conditions, the welds may include gas pockets or minute particles of foreign matter which impair weld strength. Application of the X-ray process enables Chrysler to verify quality of the work before the shell is assembled any further.

The X-ray unit operates on about 125,000 volts and was first developed for testing Chrysler-built Redstone missiles.

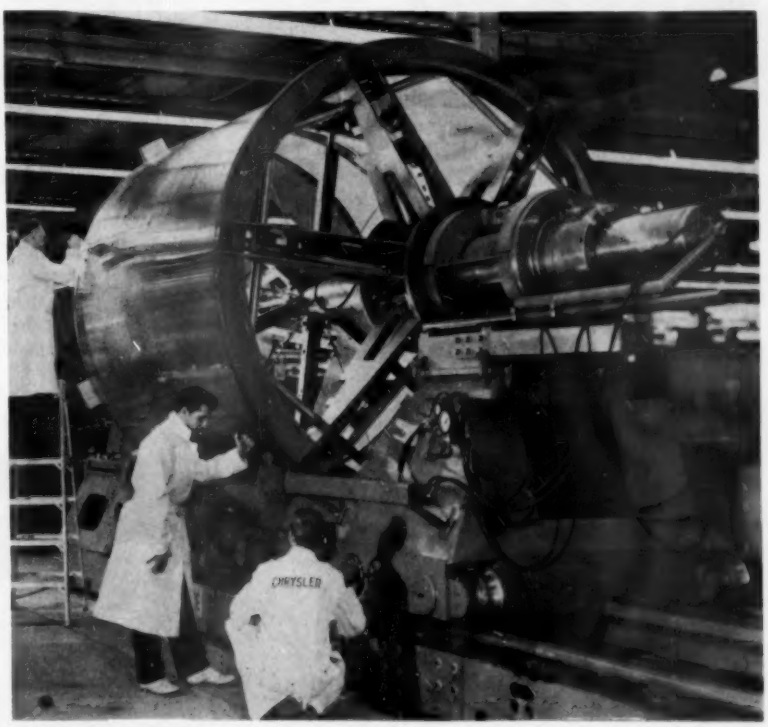
But testing doesn't end here. Among the quality-control procedures is simulated flight.

Tests conducted within a 60-ft steel tower at the plant duplicate aerodynamic loading and pressure conditions encountered by both missiles during actual firings.

Laboratory simulation of launching and flight conditions has contributed to the high degree of reliability attained by these Army missiles. (The Redstone has been fired successfully 35 out of 38 times; the Jupiter eight times, with four partially successful launchings and no failures; the Jupiter-C, a composite four-stage rocket vehicle, has been successful eight times, partially successful once and has never failed. It is the Jupiter-C that launched five Explorer satellites, two of which failed to orbit.)

Following a complete test cycle, those parts most affected by the stresses applied within the test frame are subjected to further tests inside the plant.

As a final evaluation, material samples are cut from each structural part, X-rayed, then stretched to failure.



GIANT welding fixtures such as pictured above are used by Chrysler to fabricate huge ballistic shells. Firm's Missile Division operates government-owned plant where Jupiters and Redstones are produced on assembly-line basis.

ALUMINUM bus bar for an aluminum pot-line is welded in first field application of Kaiser's Econoweld process.

by **M. B. Kasen, George Allen** and **F. R. Baysinger**

Qualiweld, Chlorecon and Econoweld were introduced in WE last year. Here is the . . .

Application data on Kaiser's new Mig techniques

APPLICATION PROCEDURES and basic welding data have been released recently on three new processes for Mig (metal inert-gas) welding of aluminum.

The patented processes, Qualiweld, Chlorecon and Econoweld, were introduced early last year by Kaiser Aluminum & Chemical Corp., and were a result of research into the causes of porosity and dross in aluminum welding. (See *Kaiser's 3 new Mig techniques for welding aluminum*, WELDING ENGINEER, March, 1958, p. 36.)

Each process requires gun modification to allow gas passage through the contact tube. With a converter part (the only change necessary) the contact tube gas may be introduced either at the gun back or, if design requires it, at the nozzle end.

Because of the chlorine used with the Qualiweld and Chlorecon processes, various additional equipment is recommended. A gas regulator made for dry chlorine service should be used, and should have a Monel check valve on the outlet to prevent entry of moist air.

A flow meter capable of accurately dispensing argon at 0.5 cfh is adequate. However, it should be resistant to dry chlorine, or at least have all its copper parts nickel-plated. (The electroless nickel process is very satisfactory.)

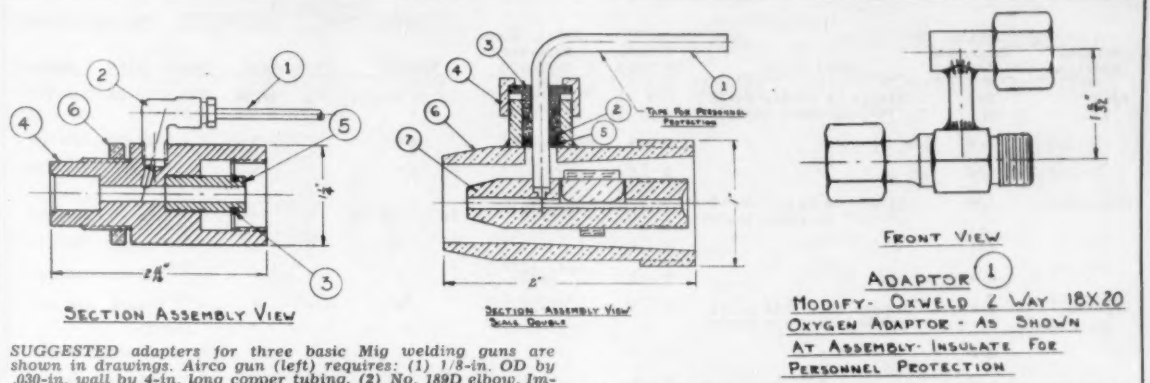
To start and stop additive gas flow simultaneously with the major shielding-gas flow, a solenoid valve, inserted in the additive line, should be connected in parallel with the gas-flow solenoid in the welding drive unit. Those parts exposed to the additive gas should be nickel plated.

Contact tubes used with these two chlorine-additive processes must be chlorine resistant. Plating of conventional copper alloy tubes by the electroless nickel process is again recommended.

Qualiweld uses either a mixture of argon plus chlorine, or helium plus chlorine in the contact tube, with argon or helium as the outer shield. Chlorine entering the arc area via the contact tube at 0.02 cfh will generally counteract hydrogen porosity normally encountered when welding with Al-Mg or Al-Mg-Mn alloy filler.

(To obtain this amount, a mixture of 97% argon plus 3% chlorine at a flow rate of 0.7 cfh, or a mixture of 99.5% argon plus 0.5% chlorine

CONTACT tube gas converter has been installed on one of the three basic Mig welding guns shown on the next page.


SECTION ASSEMBLY VIEW
FRONT VIEW
ADAPTOR (1)
MODIFY- OXWELD 2 WAY 18X20 OXYGEN ADAPTOR - AS SHOWN AT ASSEMBLY- INSULATE FOR PERSONNEL PROTECTION

SUGGESTED adapters for three basic Mig welding guns are shown in drawings. Airco gun (left) requires: (1) 1/8-in. OD by .030-in. wall by 4-in. long copper tubing, (2) No. 189D elbow, Imperial treaded sleeve, type D; (3) 5/16-in. ID by 7/16-in OD "O" rubber ring; (4) 1-1/4-in. D by 2-11/16-in. polystyrene; (5) 7/16-in. D by 1-in. polystyrene; and (6) 1-1/4-in. D by 3/16-in. brass. The GE gun (center) requires: (1) 1/8-in. D by .030-in. wall by 4-in. copper tubing; (2) asbestos string; (3) 15/32-in. D by 1/4-in. Micarta; (4) Crawford 600-7-2 swagelock tube fitting; (5) 11/32-in. OD by 5/32-in. ID by 1/16-in. Micarta washer; (6) part modification; and (7) part modification. Third gun by Linde (right) needs: (1) Oxweld two-way 18 by 20 oxygen adapter and (2) 0.040-in. D by 1-7/16-in. brass.

at 4.2 cfh, will produce 0.02 cfh chlorine. Rate of chlorine addition is not very critical.)

When additive gas flow is less than one cubic foot per hour, however, a normal flow of outer shielding gas is required. This outer flow rate will vary widely, depending on the particular conditions under which the weld will be made.

For example, an outer flow of 35 cfh may be adequate for flat position automatic welding in a draft-free location using argon. But 100 to 150 cfh may be required for overhead welding in a drafty area.

For any particular welding set-up, the required outer gas flow should be carefully checked by reducing flow until weld quality suffers. The flow should then be increased slightly to provide an adequate safety margin. Some helium is preferred for other than flat position welding.

Qualiweld is an effective means of reducing aluminum weld porosity and dross when using aluminum-magnesium filler wires. Best results are obtained in flat position with fully automatic welding. (Extensive out-of-position tests were not conducted with this process, but were made with the Chlorecon process described below.)

One weld characteristic of Qualiweld is the grey-black surface film on the deposit. This is similar to the black deposit occurring with helium-shielded aluminum welds and is caused by a light oxide coating which is easily wire-brushed.

Table 1 shows typical welding procedure data. Wide variations in current conditions from those listed can be used to meet individual requirements. Data is similar to that cited in code-qualified weld procedures.

To demonstrate Qualiweld effectiveness, a number of commercial Mig filler wires in various aluminum alloys were tested. First a control weld was made using argon in the conventional manner.

The test was repeated under identical conditions using the Qualiweld process. Radiographic tests were then run on these 34 wires. Argon plus 3% chlorine at 0.5 cfh was used in the contact tube, with 60 cfh argon in the outer shield.

A definite improvement and reduction in porosity were indicated in 16 welds; 10 were of initial high quality and unchanged by Qualiweld; 8 remained unchanged. Of the unchanged 8, only two wires were aluminum-magnesium alloy. The other six were 1100 and 4043 types, generally not improved by chlorine additive techniques.

(It should be noted that Qualiweld will reduce hydrogen-caused porosity,

Welding Position	Plate Thickness Inch	Joint Style	Number of Beads	Filler Wire Diameter Inch	Shielding Gas: Contact Tube Type	Contact Tube Flow CFH	Regular Cup Type	Regular Cup Flow CFH	Welding Current Volts	Welding Current Amps	Travel Speed ipm
Flat	1/2	60° V	4	3/32	A+3% Cl_2	1	Argon	60	24-27	325	15-18
	3/4	60°V	7	"	" "	1	"	"	"	"	"
	1-1/4	60° dbl V	12	"	" "	1	"	"	"	"	"
Vertical	1/2	70° V	6	1/16	A+3% Cl_2	2	"	"	25-27	200-220	16-18
	3/4	70° V	7 (weaved)	"	" "	2	"	"	"	"	"
	1-1/4	60° Dbl V	12 (weaved)	"	" "	2	"	"	"	"	"
Horizontal	1/2	70° V	6	1/16	A+3% Cl_2	2	"	"	25-27	220-230	15-22
	3/4	70° V	10	"	" "	2	"	"	"	"	"
	1-1/4	60° Dbl V	24	"	" "	2	"	"	"	"	"
Overhead	1/2	70° V	8	1/16	He+1/2% Cl_2	4	Helium	100	28-31	190-210	26-30
	3/4	70° V	22	"	" "	4	"	"	"	"	"
	1-1/4	60° Dbl V	28	"	" "	4	"	"	"	"	"

TABLE I—Typical procedures for welding aluminum by Qualiweld process using 5086 material with 5356 filler.

Welding Position	Plate Thickness Inch	Joint Style	Number of Beads	Filler Wire Diameter Inch	Shielding Gas: Contact Tube Type(1)	Contact Tube Flow	Regular Cup Type	Regular Cup Flow	Welding Current: Volts	Amps
Flat	3/8	Single or Double Bevel (60° Included Angle)	2	1/16	He or A+½%Cl_2	4	Argon	20	26-28	240-250
	3/4	"	3 - 4	3/32	"	"	"	"	26-30	280-300
	1-1/4	"	6 - 8	"	"	"	"	"	"	320-370
Horizontal	3/8	Single or Double Bevel (60-90° Included Angle)	2 - 3	1/16	He + 1/2% Cl	"	"	"	26-28	220-240
	3/4	"	5 - 6	"	"	"	"	"	26-30	220-240
	1-1/4	"	7 - 9	3/32	"	"	"	"	26-30	250-280
Vertical	3/8	Single or Double Bevel (60-90° Included Angle)	2 - 3	1/16	"	"	"	"	26-28	180-220
	3/4	"	5 - 6	"	"	"	"	"	26-30	190-230
	1-1/4	"	7 - 9	3/32	"	"	"	"	26-30	260-290
Overhead	3/8	Single or Double Bevel (60-90° Included Angle)	3 - 5	1/16	"	"	"	"	26-28	180-200
	3/4	"	10 - 12	"	"	"	"	"	26-30	180-200
	1-1/4	"	18 - 20	"	"	"	"	"	26-30	190-220

(1) With 1100 and 4043 fillers, inert gas at 5 cfh down the contact tube can be used without the Cl addition.

TABLE 2—Typical procedures for welding aluminum by Chlorecon process using 5086 material with 5356 filler.

but not necessarily porosity caused by other variations, *i.e.*, excessive current, loss of shielding, improper welding techniques.)

The Chlorecon process is similar to Qualiweld and uses either an inert-plus-chlorine gas or an inert gas in the contact tube with a low flow of inert gas in the outer shield.

In this process, outer-shield gas flow is reduced to 15-30 cfh. These low flows are possible because of better shielding efficiency from the dual effect of contact tube gas and the outer shielding gas. Helium plus 0.5% chlorine at 4 cfh is the preferred contact tube gas.

Welding procedures for Chlorecon are given in Table 2. Manual Mig welding in all positions is preferred. Automatic welding is not generally

Parent Plate	Filler Alloy	Welding Position	No. of Tensile Specimens	Avg. Tensile Strength psi	Avg. Yield Strength psi	Avg. Elong. % in 2 in.	180° ASME Bend Test
With Chlorine (2-4 cfh He with 0.5 % Cl through the contact tube + 20 cfh Argon through the regular nozzle							
EC-H12	1100	Vertical	12	10600	(1)	34.2	12 Sound
		Overhead	12	10900		30.	12 "
6061-T6	5356	Vertical	12	30500	(1)	12.0	12 "
		Overhead	12	31500		11.0	12 "
5083-H113	5356	Vertical	12	40600	(1)	16.4	9 passed 3 failed
		Overhead	12	40100		15.1	6 passed 6 failed
5086-H32	5356	Vertical	12	39900	(1)	21.3	11 passed 1 failed
		Overhead	12	38500		17.2	7 passed 5 failed
Without Chlorine (5cfh He through the contact tube + 15 cfh Argon through the regular gun nozzle.							
EC-0	1100	Vertical	6	10500	4000	62.8	6 Sound
		Overhead	6	10600	4300	59.3	4 "
5083-H113	5183	Vertical	6	42000	19200	16.8	7 passed 1 failed
		Overhead	6	41600	19800	17.0	2 passed 4 failed
5086-H32	5356	Vertical	6	37900	17100	14.5	8 Sound
		Overhead	6	39100	14700	20.6	8 passed 1 failed
5086-H32	5183	Vertical	6	39100	16700	21.0	12 Sound
		Overhead	6	39300	16500	22.0	9 passed 3 failed

(1) Not determined.

TABLE 3—Mechanical properties of Chlorecon weldments in various aluminum alloys.

Welding Position	Plate Thickness Inch	Joint Style	Number of Beads	Filler Wire Diameter Inch	Shielding Gas: Contact Tube Type	Contact Tube Flow CFH	Regular Cup Type	Regular Cup Flow CFH	Welding Current Volts	Welding Current Amps
Flat	1/4	Sq. butt	2	1/16-1100	Helium(1)	5	Nitrogen	15	29-30	200-210
	3/8	" "	2	1/16-1100	"	"	"	"	"	240-250
	3/4	70° V	4	1/16-1100	"	"	"	20	"	"
	1-1/2	60° Dbl V	10	3/32-1100	"	"	"	"	"	285-300
Horizontal	1/4	Dbl Fillet	1 each side	1/16-1100	"	"	"	15	29-30	210-230
	3/8	" "	" " "	1/16-1100	"	"	"	"	"	230-250
	3/4	" "	3 " "	3/32-1100	"	"	"	20	"	260-280
	1-1/4	" "	6 " "	3/32-1100	"	"	"	"	"	280-300

(1) Contact tube gas should be determined by experimentation. With some power supplies, better welding characteristics are obtained with argon.

TABLE 4—Typical procedures for manually welding aluminum by Econoweld process using EC material with 1100 filler.

recommended since high travel speeds with low gas flows outrun the shield and expose the pool to air.

To minimize porosity with aluminum-magnesium fillers (5000 series) in all positions, helium plus 0.5% chlorine gas may be used. With other fillers, welds can be made with 5 cfh straight argon in the contact tube instead of a chlorine mix.

Mechanical properties of Chlorecon weldments with and without chlorine are shown in Table 3. Note that all data in this table is obtained from welds made in vertical and overhead positions. This is also assumed valid for flat position welds.

Tensile strength and elongation values of transverse weld tensile bars, flush-machined, fall within the range of values previously published for conventional welds with each alloy, temper and filler combination. Bend tests, however, showed failure of about 50% with both the chlorine additive and straight dual-shield low gas flow methods. No comparable bend test data for out-of-position welds by conventional methods is available, so some difficulty should be expected in meeting all code requirements at 20 cfh for this welding. Higher gas flows are therefore recommended for code applications.

The Econoweld process uses 5 cfh of inert gas through the contact tube and a minimum of 15 cfh nitrogen in the regular outer shield. Helium, argon-helium mixtures, or argon, in that order, are preferred for use in the contact tube.

(Contact tube gas-line requirements are similar to those for the other two processes, except no special plated or chlorine-resistant materials are required.)

Some difference has been observed in arc operation between constant voltage and drooping characteristic power supplies when used with this process. Choice of contact tube gas for test arc stability has also been found to vary with power supply.

Econoweld will be slightly more difficult for weldors until they become accustomed to the required short welding arc technique. The arc is smooth with 4043 alloy wire, however, a little more splatter occurs with 1100 and 5000 series fillers.

Welding procedures and mechanical properties are shown in Tables 4 and 5 respectively.

Tensile values obtained in EC aluminum transverse tensile specimens (11,000 psi ultimate, 5,000 psi yield, 48% elongation) compare well with values obtained with argon-shielded EC welds.

Alloy 3003 welded with 1100 alloy filler had 15,000 ultimate tensile strength and 34% elongation. Values for 6061, 5053 and 5086 alloys, however, were somewhat lower than obtained with conventional welding. Bend tests were good with EC, 3003, and 6061, but not with 5083 and 5086.

Cause of the tensile strength and ductility loss is believed to be the higher magnesium burn-out with nitrogen shielding. For this reason Econoweld is not recommended for use on ASME unfired pressure vessel work, particularly with 5000 series alloys.

For electrical bus welding, bead reinforcement should be left on the bus to offset the 8% high average resistance of the weld metal as compared to the parent bus.

Parent Plate Alloy	Filler Alloy	No. of Specimens Based on Results	Avg. Tensile Strength-psi	Avg. Yield Strength-psi	Avg. Elong. % in 2 inches	180° ASME Bend Test
EC	1100	215	11,600	5,500	48.0	Sound
3003	1100	12	15,600	(1)	34.8	11 Passed 1 Failed
6061	4043	10	25,500	15,900	4.5	(2)
	5356	16	27,800	(1)	8.2	Sound
5083	5356	16	37,600	(1)	11.0	All Failed @ approx. 90°
5086	5356	16	35,700	(1)	13.2	"

(1) Not determined.

(2) A 4-T diameter bend test was done on the specimens in the 6061-4043 series. This is a more severe bend test than required by ASME for 6061 with 4043 or 5356 filler alloy.

TABLE 5—Mechanical properties of weldments in various aluminum alloys made by Econoweld process.

Courtesy of Hobart Bros. Co.

AUTOMATIC submerged-arc welding is used to prepare ear blanks. Selection of wire must give the best balance between weld quality and cost.

The final article in a series . . .

Filler metals for joining

by **Orville T. Barnett***

ALTHOUGH BARE WIRES are used extensively in automatic, semiautomatic and manual welding of carbon and low alloy steels, no definite AWS specification has been published.

Pending issuance of formal specifications on this highly complex classification, a temporary table has been compiled, adhering as closely as possible to AWS procedures and terminology.

For example, in the table, "E" (electrode) and "ER" (filler rod) describe submerged-arc and gas-shielded welding wire, or Tig filler rods as in standard specifications.

The numbers following the symbol represent minimum tensile strength obtained when inert-gas welding the material. (When such figures are not available, submerged-arc ratings are used instead.)

This system is based on the fact that inert-gas shielding neither adds to, nor subtracts from, the deposited weld metal's alloy content. Submerged-arc fluxes, however, are usually modified to affect weld deposit chemistry and mechanical properties, and furthermore, human and mechanical elements can cause submerged-arc deposit strengths to vary.

The final portion of the specification indicates metal type, *e.g.*, "Fe" for iron; "St" for steel; and the suffixes "HT1," "HT2," etc., for separate wire analyses. (These suffixes parallel as closely as possible the approved AWS-ASTM classifications made for low-alloy-steel coated electrodes.)

No attempt has been made to categorize special bare wires used in automatic welding. One of these is a hollow tube containing flux and gas shielding ingredients. Another hollow-type contains flux and deoxidizing chemicals, but is encompassed by a CO_2 shield. Still another wire carries magnetized flux into the arc, and receives added protection from a carbon-dioxide shield.

With such a wide array of materials from which to choose, welding engineers must select that process and filler metal providing the best balance between weld quality and cost.

Wire package selection is not as simple as it would seem. One manufacturer, for example, markets wire packaged in 11 different ways.

These range from 25 to 80-lb coils wrapped in waterproof paper and strapped with steel, to 1,200-lb spools. Straight lengths are wrapped in burlap or placed in paper boxes.

To keep wire clean and rust-free is the chief reason for these packaging methods. Many wires are flash coated with copper to further discourage rusting. If the welding engineer's objective is a clean wire, the more expensive packaging is warranted.

On low-production work, smaller wire quantities are advisable. On the other hand, high production rates certainly call for large quantity packages to minimize downtime for wire changes.

Most bare welding wire is used in submerged-arc welding of low-alloy and mild steels. However, CO_2 shielded welding of mild steel is increasing while Mig and Tig have gained wide support for welding low-alloy steels.

Application of those wires listed in the table is as follows:

ER45-Fe and ER50-St—The first is applied to Armco iron, cast iron or mild steel, while the second is used on low-carbon steel. Inert-gas welding is the preferred method of application.

ER55-St and ER65-St—Of the two grades, the former is more widely used, although both are suitable for general purpose welding on mild steel. These wires are used to produce butt and heavy fillet welds which will be subjected to intense shrinkage stresses. Among the steels welded by submerged-arc using these filler metals are ASTM-A7, A129 and A285.

ER75-St-HT1 and HT2; E75-St-HT3 and HT4—The HT1 and 3

*Assistant manager, Metals Research Department, Armour Research Foundation of the Illinois Institute of Technology, Chicago.

Comparison chart of iron, steel automatic welding wire

Suggested Class.	Description	Air Reduction Sales Co.	Hobart Bros.	Lincoln	Linde Oxweld	McKay	Metal & Thermit	NCG	Page	Reid-Avery	A.O. Smith	Westing-house
ER45-Fe	Pure iron	--	--	--	--	--	MT1001	--	A-S-Armco	--	--	--
ER50-St	Low-carbon steel	A675	--	--	7, 43	MK-80 & 82	MT 1004	NCG No. 1	A-S-6	.06 Carbon	--	--
ER55-St	Med.-carbon steel	--	H-10	L-60	1, 43	MK-83	MT 1011	--	A-S-10	.08-.10 C	--	MS-21
ER65-St	Med.-carbon killed steel	--	H-20 or H-25	--	1 HT, 32, 35, 36, 66	--	MT 1005	--	A-S-20 or A-S-25	--	--	MS-20
ER75-St-HT1	High-tensile steel	A628	H-15	--	1 HT, 29, 32	MK-84	MT 1314	NCG No. 6	A-S-15	Hi-Mang.	--	--
ER75-St-HT2	High-tensile steel (inert gas)	A613	H-15	--	32, 65	--	MT 1316	NCG No. 6	A-S-15	Hi-Ten. Spec.	CO-85	--
E75-St-HT3	High-tensile steel (submerged-arc)	--	H-15	L-61	35, 36, 40A 40B, 40	MK-84	MT 1313	NCG No. 101	A-S-15	Hi-Tensile	--	--
E75-St-HT4	High-tensile steel (CO_2 gas)	--	--	--	65, 68	--	MT 1315	No. 101, Dual Shield 150, 151	A-S-18	--	CO-86	--
ER85-St-A1	C-Mo Steel	--	H-16	L-70	40	--	MT 1314-Mo	--	A-S-16	Hi-Mang-Mo	--	--
ER85-St-B2	Cr-Mo Steel	--	--	--	40, 502, 515	--	MT 4107-B2	--	A-S-4130	1 Cr - 1/2Mo	--	--
ER95-St-B3	Cr-Mo Steel	A725	--	--	502, 521	--	MT 4108-B3	--	--	2Cr - 1 Mo	--	--
ER90-St-B	Cr-Mo steel	A725	--	--	521	--	MT 4130	--	A-S-4130	4130	--	--
ER80-St-G	Cr-Ni-Mo steel	--	--	--	71, 68	--	MT 8620	--	A-S-8620	8620	--	--
ER85-St-G	Cr-Zr steel	A725	--	--	--	--	MT 9115	--	NAX-9115	--	--	--

**These suggested classifications adhere as closely as possible to the American Welding Society procedures for terminology. The comparable manufacturers' classifications were compiled from the most recent available information.*

Class	Description	Submerged-arc						Gas-shielded*	
		Strength as-welded (psi) Yield	Ultimate	Elong. (% in 2 in.)	Stress relieved (psi) Yield	Ultimate	Elong. (% in 2 in.)	Strength as-Welded Ultimate	Elongation (% in 2 in.)
ER45-Fe	Pure iron	--	--	--	--	--	--	45,000	40.0
ER50-St	Low-carbon steel	--	--	--	--	--	--	50,000	35.0
ER55-St	Med.-carbon steel	56,100	68,700	28.5	44,700	63,500	34.0	55,000	30.0
ER65-St	Med.-carbon killed steel	52,000	70,000	35.0	--	--	--	67,000	30.0
ER75-St-HT1	High-tensile steel	--	--	--	56,600	74,200	27.5	75,000	40.0
ER75-St-HT2	High-tensile steel (inert-gas)	--	--	--	--	--	--	75,000	26.0
E75-St-HT3	High-tensile steel (submerged-arc)	59,900	77,900	28.0	51,000	72,000	31.0	75,000	26.0
E75-St-HT4	High-tensile steel (CO_2 gas)	--	--	--	--	--	--	75,000	30.0
ER85-St-A1	C-Mo steel	70,200	83,600	23.0	66,900	79,900	27.5	85,000	20.0
ER85-St-B2	Cr-Mo steel	--	--	--	--	85,000	25.0	--	--
ER95-St-B3	Cr-Mo steel	--	--	--	--	95,000	20.0	--	--
ER90-St-B	Cr-Mo steel	--	--	--	--	--	--	90,000	15.0
ER80-St-G	Cr-Ni-Mo steel	--	--	--	--	--	--	80,000	40.0
ER85-St-G	Cr-Zr steel	--	--	--	--	--	--	85,000	15.0

Argon or helium shielded except E75-St-HT4 which is CO_2 shielded.

TABLE shows the mechanical properties of weld metal deposited by iron and steel rods and wires. Suggested classifications parallel as close as possible AWS-ASTM procedures.

filler metals are used for submerged-arc welding on many high-strength steels when butt or fillet welds are made with single or multiple passes. They also perform well on as-welded and stress-relieved weldments.

This filler metal is suited for welding on the following base metals: ASTM-A7 steel for bridges and buildings; ASTM-A53 welded and seamless steel pipe; ASTM-A131 structural steel for ships; ASTM-A201 carbon-silicon steel plates for boilers and pressure vessels; ASTM-202 chrome-manganese-silicon alloy steel plates; ASTM-A203 low carbon-nickel plates (provided impact values are high enough at service temperatures); ASTM-A212 carbon silicon plates for boilers and other pressure vessels; ASTM-A283 mild steel structural plates; and ASTM-A285 carbon steel plates.

An ER75-St-HT2 filler metal can be used in an inert-gas atmosphere for heat treatable steels and pressure vessels, or occasionally with CO_2 on mild steel.

With an argon-1% oxygen shield, manganese and silicon blend into the weld metal with practically no loss, thereby producing stronger welds. However, when CO_2 is used, the manganese and silicon are consumed in overcoming oxidizing effects of the arc, resulting in lower weld strength.

To offset this, enough manganese and aluminum is added to the HT4 filler metal to produce sound welds even with CO_2 shielding. Single and multipass welds have proved sound. Now in widespread use on mild steel, it has been successfully applied to some higher carbon, sulphur-bearing and low-alloy steels as well.

ER85-St-Al—This filler metal provides a balanced deposit for butt and fillet welds on carbon-molybdenum steel, high-tensile steels and alloy steels in weldments that are almost always stress relieved.

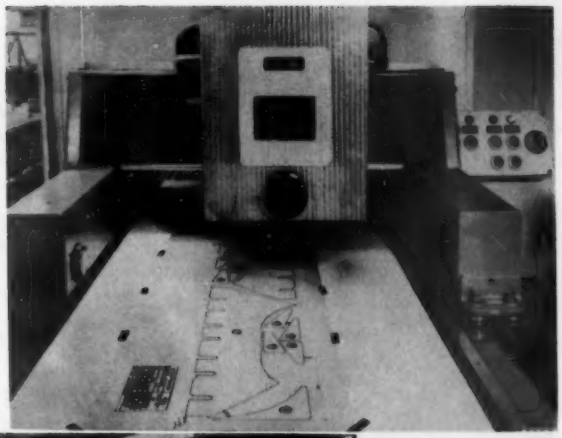
It is used most frequently on the following: ASTM-A202 chrome-manganese-silicon steel plates; ASTM-A204 molybdenum steel plates for boilers and other pressure vessels; and ASTM - A225 manganese - vanadium steel plates for boiler and pressure vessels.

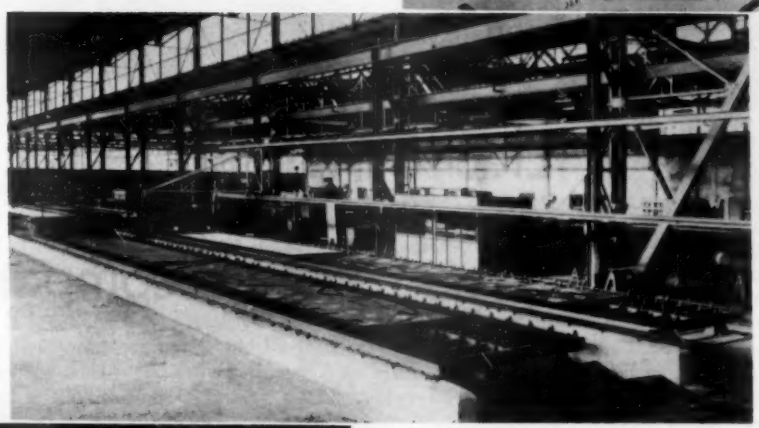
ER85-St-B2 and ER95-St-B3—Both are intended for chrome-moly pipes on pressure vessel welding.

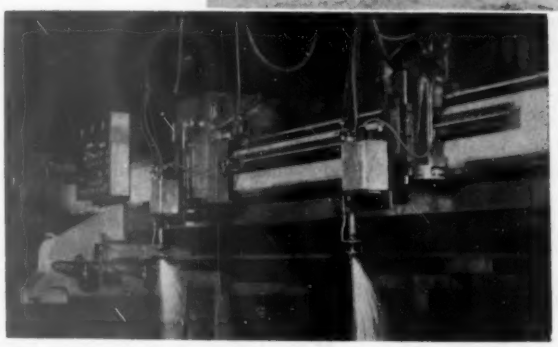
ER90-St-B, ER80-St-G and ER-85-St-G—These wires are used with an inert gas to weld such construction alloy steel as AISI-4130, AISI-8620 and SAE-9115. They have contributed to the advancement of welding aircraft structures, machinery parts and transportation equipment, which require both light weight and high strength.

Although automatic welding does not seem destined to replace manual joining with coated electrodes as the prime steel welding method, it has enjoyed a steady growth in the past 20 years. This growth will continue as new wires, fluxes and gases give impetus to automatic welding applications.

PILOT machine (right) operates the one-to-ten Messer Sicomat cutting machine, which can cut two plates simultaneously. Center photo shows the plates, each with a 12-ft-wide maximum, being cut on the work tables. Bottom photo is a close-up of the cutting torches.







Cybernetics— automated cutting for greater profits

"CYBERNETICS" PROVIDES the key to important future advances in oxygen cutting processes, according to Richard L. Deily of Messer Cutting Machine, Inc., New York.

(Deily will speak on cybernetics of oxygen cutting at the annual AWS national meeting in Chicago. He defines cybernetics in industry as "automated processes for greater profits.")

Application of automated cutting processes has been a long-established goal, and automated cutting techniques developed in Europe can be applied to many uses in the U. S.

The application of electronic controls to oxygen cutting machines now permits the use of one-to-one scale drawings, one-to-ten scale drawings and remote control from any location.

Most important of all, for future development, taped information from computers can be analyzed and used for furthering such processes, said Deily.

Among the fields which offer great promise for wider application and improved use of these cutting systems are hot cut-off in steel mill rolling lines, plate edge preparation, and integration of manufacturing operations using steel plate.

The impact of new control techniques will be assessed and improved in coming months, Deily stated.

Problems such as precision design of torches and tips, the study of material handling and plate supports for reducing plate movement during cutting, and variables in oxygen cutting processes themselves will require further study and analysis.

However, the promise of achieving greater accuracy and wider use of oxygen cutting seems assured, said Deily.

ELECTRO-mold weld is made by feeding wire into a well enclosed by water-cooled copper dams. Flux is fed each 15 seconds in small amounts.

by **R. L. Peterson**
Electro-Motive Div.
General Motors Corp.

Lighter, stronger and less costly . . .

Electro-molding replaces forged engine components

LIGHTER, STRONGER, within closer dimensional limits than castings—that's the description used for locomotive engine components currently being welded at an Electro-Motive Div. plant of General Motors Corp. on Chicago's far south side.

Except for moving parts, the engines can be considered as almost all-welded fabrications. One example of a diesel engine component is a cylinder head retainer.

These sleeve-like parts with tapered walls are welded into circular top openings of cylinder blocks. After some machining, an opening is flame-cut at one end of the retainer. An exhaust elbow (also a weldment) is then arc-welded into the hole.

When forged, these parts were expensive both in initial cost and in required machining. And because of the tapered section, forming and then welding longitudinally presented too many problems.

Thus experiments were conducted with "electro-molding," a process in which a weld is made inside mold-like copper dams. Although a special machine setup was required, the resulting single-pass, uniformly high quality welds warranted it.

The retainer section is generally wedge-shaped and measures 7 in. parallel to the sleeve axis; however, there is a 3/8-in. step 3 in. from the inner wall top. Outside at the top, there is a 30-deg taper to the point of maximum thickness (1-21/32 in.) and then a 7-deg taper from this point to the lower end.

In a normal cycle, 30 bars are fed automatically through the walking beam furnace and are heated to 1,700 F, one bar being loaded and one discharged every 4 minutes.

Leaving the furnace, bars are power-fed lengthwise into a bulldozer where a curved-recess die forms the piece around a fixed mandrel until a sleeve of the desired diameter and gap is produced. When formed to size, the sleeve is lifted by trolley tongs for removal to the three-station electro-molding machine.

Each sleeve, with its thicker section on top, is lowered over a central mandrel and hydraulically clamped to bring the weld gap to the correct 1-in. width between the square and parallel ends. Clamping includes hydraulically closing the water-cooled copper dams, one inside, the other outside the retainer.

At the bottom a 1/2 by 3/4-in. bar is placed radially in its own dam recess and is gripped by a ground clamp.

A 7-in. deep by 1-in. wide well (varying radially in thickness) is left to be filled with weld metal, which

BAR of wedge-shaped section (above left) enters the bulldozer for forming operation. After first operation, additional forming approaches final shape (above right).

WELDED retainer is ready to be lifted out after clamps and copper dams have been retracted. Weld is outlined in black.

fuses with the side-walls but not with the copper dams. Protective flux is fed so as to keep the pool submerged and adjacent copper walls covered with a fused flux skin.

The Lincoln Electric welding head (arranged to weld in all three stations) feeds a 7/32-in. mild steel wire downward into the weld axis. Wire is fed through a close-fitting copper sleeve which carries the current to the wire. At its lowest point, the sleeve is 3 in. above the well bottom.

When the arc is struck, the wire retracts to hold a nearly constant arc length. Rate of retraction is not constant because of the varying radial weld thickness.

Thus the head is elevated at two different rates: faster in the first half where the section is relatively thin; slower above this where the section is thicker. A special mechanism varies the lift rate and the copper wire-sleeve rises with the head.

[*Ed. note*—The process described here is reminiscent of the "electroslag" process developed by the Russians and reported by WELDING ENGINEER, November, 1957, p. 53. The Russian method uses two or more electrodes to supply welding heat under a molten slag. Water-cooled shoes are placed against the vertical plate edges to contain the weld metal and slag. Temperature-sensing probes regulate upward travel of the welding head.]

Welding at EMD is done at about 38 volts, d-c straight polarity, providing an average current of about 1,150 amp, supplied from two 750-amp generators. Voltage and current, however, are increased slightly as welding proceeds.

A completed weld takes about 4½ minutes arc time. (This does not include loading, clamping and unloading time.) Approximately eight retainers per hour per head can be completed.

Generally, only two stations are used at a time; work is loaded in one while a retainer is welded in the other. The third station is in reserve should any repairs and adjustments be needed in either of the other two stations.

Since the molds do not always fit perfectly, asbestos cement is generally required for calking joints at the copper backups to avoid molten metal loss. Each weld thus becomes a small electric-arc furnace in which a "hot top" is formed and the resulting "pipe" is cut off.

Before entering the welding head feed rolls, wire is passed through two pairs of straightening rolls at right angles and above the head. These extra rolls keep the electrode straight and prevent deviation from the well center.

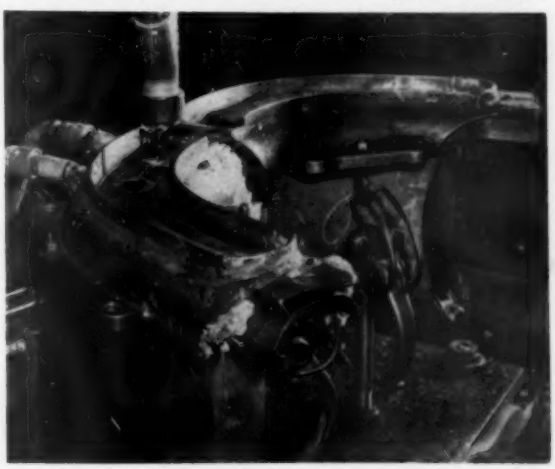
Conventional flux is used; however its feed rate is substantially slower than in normal submerged-arc welding, since this high rate would fill the well and interfere with proper welding. Instead of the normal flux feeder, a timer dispenses a fixed amount of flux at 15-second intervals. This is sufficient to properly cover molten metal surfaces, but still submerge the arc entirely. No flux recovery is necessary since all flux is fused.

After the weld is complete, the head is moved to one side or to another station. Copper dams are removed hydraulically, releasing the weldment which is lifted out with loading tongs. The grounding bar is then cut off and the weldment is ready for machining.

Total cost per piece is approximately 11 to 12 cents a pound, compared to 19 cents a pound for forgings, which weigh more, involve more waste and require more time for machining.

Three retainers are placed in a three-torch flame-cutting machine which cuts an elongated hole in each. An exhaust elbow will then be welded into the hole.

The cutting unit has templates to determine the elongated pattern of horizontal torch travel. Since each retainer is circular, however, torches must rise and fall to produce the hole



HORN fixture holds two pairs of exhaust elbow stampings for welding. While one pair is welded, the second is unloaded.

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through the curved walls and are mounted on a cam-operated horizontal bar.

Each retainer is clamped in a fixture for correct positioning. Loading and unloading is facilitated by a cable lift supported on a trolley rail. Trunnioned fixtures are partly used for holding retainers while manual arc-welding them to mating crankcase holes. In this way the weldment can be rotated to the most convenient position for the weldor.

The curved exhaust elbow is formed from two stampings arc-welded together along the seams. Each weld is in a horizontal plane when the stampings are clamped with edges parallel in the fixture.

A horn-type fixture having a copper backup bar forms the inside weld bead. A flux dam is placed on each side above the weld. Each fixture holds two pairs of stampings, one being loaded while the other is welded. When one weld is completed, the Lincoln welding head shifts to the second pair. Thus the machine is in continuous operation.

Both exhaust elbows are ¼-in. steel and are clamped to leave a 5/32-in.-wide groove between edges. Wire, fed through an automatic submerged-arc welding head, is made to follow the groove by a cam of the same contour. After one edge is completely welded, the stampings are turned over for joining the opposite edges.

For this welding, a 7/32-in.-diameter wire is used with an adjusted voltage of 650 amp d-c current, and a welding rate of 17 ipm. Each weld follows a 9-in.-long arc and then a straight line 3 in. long. A crowned bead is produced on both sides of these welds; the inside one formed by the water-cooled copper backup.

The completed elbow's straight end is fitted into the flame-cut hole in the retainer wall and is manually arc-welded around the hole contour. The entire assembly is then ready for welding to the crankcase.

When two full rows of these retainers are welded to a crankcase, the outer edges of all elbows are in two parallel rows in the V between cylinder rows. Thus all elbows can enter one central exhaust manifold.

Compared in every important design factor (weight, strength and cost), these welded components win over any forgings.

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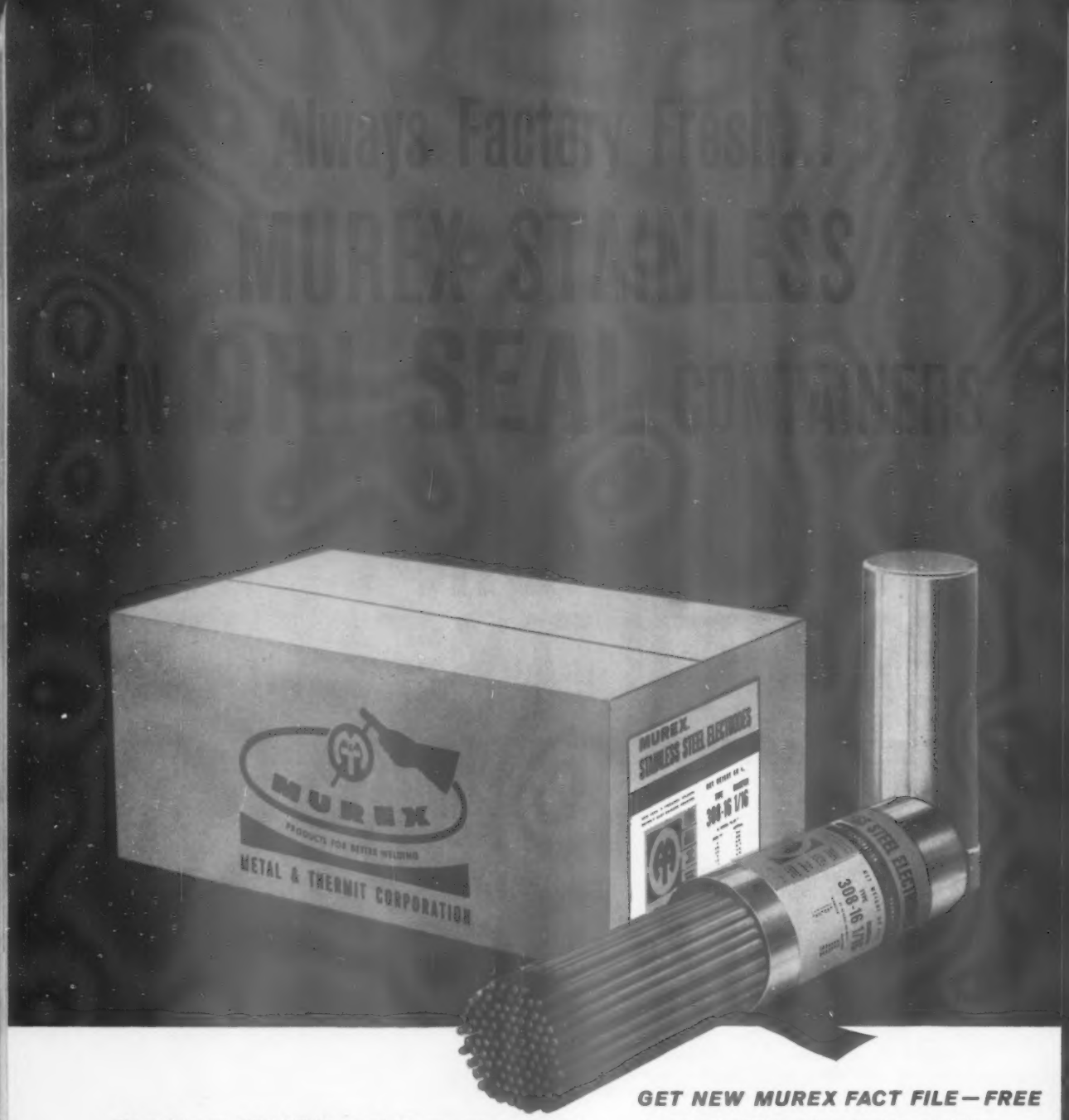

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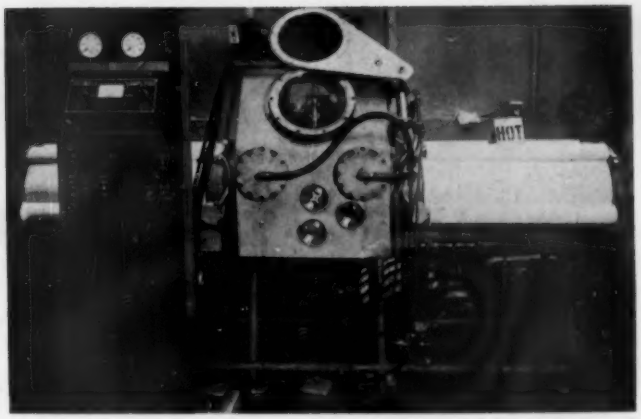
There's always a way . . .

Argon pinch-hits for helium in Zircaloy-2 welding operations

by **H. E. Soisson***



CONTROLLED atmosphere chamber in which helium and argon samples were welded.

SINCE IT BECAME KNOWN the helium supply in the United States was insufficient to meet increased military and civilian demands, the Bureau of Mines has urged consumers to replace helium with another gas wherever possible.

Heeding the request, the advance manufacturing engineering division of Knolls Atomic Power Laboratory, Schenectady, N. Y., began experimenting to determine if argon could supplant helium when welding reactor grade Zircaloy.

Tests proved argon can do the job. Weldments of Zircaloy-2 under an argon atmosphere have met the corrosion resistance specifications necessary for naval reactor applications.

During experiments, specimens of Zircaloy-2 were Tig (tungsten inert gas) welded in a controlled atmosphere chamber evacuated to a pressure of 0.03 microns. Backfill gases were at least 99.99% pure.

A two-pass weld, with no backing for chilling, was made with a 1/16-in. tungsten electrode containing some zirconium. Each weld was laid at a rate of 5.6 ipm. Sectioned specimens showed 90% penetration for each pass.

Each of the weldments was made across the 1-in. width of pieces measuring 1 by 2 by 0.104-in. Twenty-four specimens were welded, 12 each under argon and helium atmospheres so comparisons could be made.

Another group, this time consisting of eight specimens, was welded under variable pressure and backfill conditions. This was done so evacuation and backfill requirements could be established to meet corrosion resistance specifications.

After welding, the specimens were X-rayed for penetration and voids, subjected to bend tests for ductility over a 1/16-in. mandrel, and corrosion tested for gas and contaminate pickup.

X-rays showed good penetration on all argon and helium welded specimens. No voids were detected.

Equally good results were found in the corrosion and ductility tests, with no significant differences noted between the samples.

Prior to welding and corrosion testing, 22 specimens were pickled using standard procedures. Two samples were not pickled before welding, but were treated prior to testing.

The two not pickled until testing showed a weight change rate of 3 mg/dm² greater than the other specimens.

Specimens welded in argon showed approximately the same face width of weld area in the weld joint as the helium specimens, though the argon welds had a slightly larger grain growth.

Only two major differences were detected in the testing. Argon welding produced more heat than helium welding, and it took an argon-welded specimen longer to cool than a helium specimen. However, neither difference adversely affected the physical characteristics of the parent metal.

Helium-argon welding test data

Specimen	Welding chamber Micron pressure	Backfill	Atmosphere	Amp (Straight polarity—d-c)	Arc volts
1	0.1	1	Helium	22	20
2	0.1	2	Helium	22	20
3	0.05	1	Helium	22	20
4	0.05	2	Helium	22	20
5	0.1	1	Argon	80	10
6	0.1	2	Argon	80	10
7	0.05	1	Argon	80	10
8	0.05	2	Argon	80	10

Welding data for both helium and argon. Information was taken from 1% accuracy meters used with automatic Tig head. Same speed of head travel was maintained throughout testing. All samples were pickled before welding.

*Advance Manufacturing Engineering of Knolls Atomic Power Laboratory, operated by General Electric Co. for the Atomic Energy Commission.

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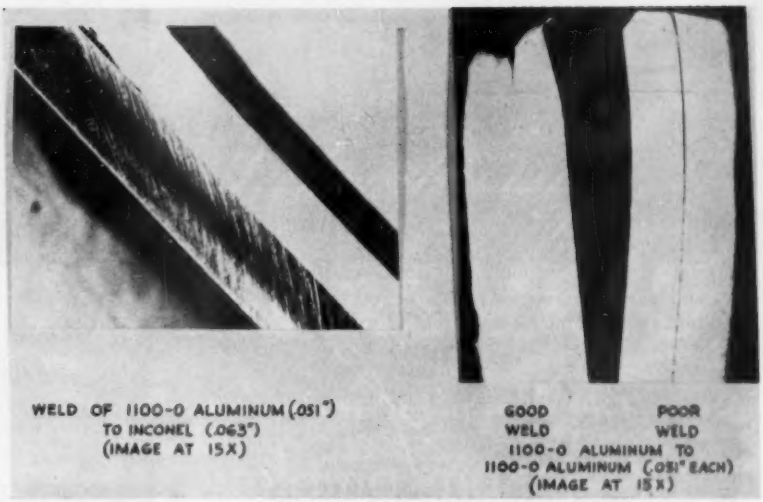
by **Jack Fairlie**



WELD OF 1100-0 ALUMINUM (.051") TO INCONEL (.063") (IMAGE AT 15X)

GOOD WELD — POOR WELD
1100-0 ALUMINUM TO 1100-0 ALUMINUM (.051" EACH) (IMAGE AT 15X)

Explosive welding and forming open another door for industry

THOUGH STILL VERY MUCH in an experimental stage, explosive welding is nevertheless a reality at National Northern Corp.'s installations in West Hanover and Halifax, Mass.

Basically interested in developing, producing and testing explosives, igniters, propellants, pyrotechnics, ballistic devices, etc., this division of American Potash & Chemical Corp. began a search five years ago to unearth more diversified uses for its products. One of the most remarkable rewards of this work was an explosive metal-working process on which National Northern now has a patent application.

That the firm's explorations in 1954 and 1955 should be directed toward explosive forming wasn't strange—or accidental. Both German and British engineers were awarded patents on such work as far back as 1900. National Northern's efforts were fortunate, however, because in the intervening years, very little has been done to perfect work begun over a half-century ago.

First applied (under Navy subcontract to Ingersoll Kalamazoo Div. of Borg-Warner Corp.) to rocket nozzles for a large missile and to honeycomb structures for airframes, the explosive method worked startling results. But National Northern discovered at this time that the results observed in one job couldn't necessarily be duplicated in another with the same test set-up.

In forming the rocket nozzles, for example, carefully-regulated explosive charges were applied to welded, 1020-steel tubes. The force of the blast caused a metal elongation of up to 70%—increasing tube diameter where desired from 10 to 17 in.

The honeycombed structures, however, were quite another matter. "In fact," states Vasil Philipchuk, manager of the firm's special projects department, "the only common property of the two products was that the materials were steel. Differences, on the other hand, were many: alloy content, hardness, tensile strength, shape, and percent of deformation required to obtain the final shape."

Its experiences with these products conclusively indicated to National Northern that a great deal of data on the ability of various metals to be formed explosively was badly needed. The firm set out late in 1957 to compile this information; its research program, still in full swing, has not only resulted in a virtual library of data on forming, but has explored the related fields of explosive forging, welding and bonding.

In brief, here are some of the more important facts which have been uncovered by National Northern's test group:

1. Four factors are highly critical in determining the success of an explosive forming or welding operation:

the type, amount and shape of the explosive charge, plus its location.

2. An explosive charge placed in water—or in some other media that will transmit the force of the blast (*e.g.*, talc, clay, plastic, oil, etc.)—*can be 10 times smaller than a charge used in the open air to do the same job.*

3. The explosive used should provide a force having proper distribution and quantity for a specific forming.

4. Cast steel can be the most commonly used die material—though National Northern researchers have also employed concrete or plastic on occasion.

Before entering into a discussion of explosive welding, it might be well to take a closer look at just what is involved in forming by means of explosives. There is, initially, "a rapid movement of metal through its elastic range and into the plastic range, producing permanent set or shape within microseconds," according to Philipchuk.

In this unbelievably high rate of stress application is found the essential difference between the explosive metal-forming method and conventional forming conditions. Initial stress loads in the latter are considerably lower.

National Northern authorities admit that, even today, their understanding of the changes occurring in metal subjected to explosives is largely theoretical. They do know, however, that it is the cohesive and repulsive forces acting between atoms in a metal crystal which are disturbed and rearranged during explosive forming. Termed a *slip*, this deformation occurs along many planes in the crystal grain.

According to Philipchuk, "total deformation of a specimen is the integration of many small displacements along many slip planes." When the grain boundary is encountered, slip interference (braking) takes place, causing atom adjustment (healing) due to cohesive forces between atoms."

Continuing, Philipchuk notes: "It can be theorized that under high stress-strain rates associated with explosive forming, atoms go through a series of slip, brake and heal events very rapidly. Failure will occur when the healing process or cohesive forces between atoms are unable to cope with the continued process of slipping."

Philipchuk attributed this occurance to an excessive stress duration and points to the need for close control of this factor.

National Northern's basic study on the behavior of plastic flow produced by explosive forces has been aimed "at obtaining a relationship between the known conventional plasticity of metals and that which is possible under high stress rates." An evaluation of data obtained from the firm's explosive forming program indicates that a metal's ability to be formed by explosives is a direct function of one mechanical property—*the percent of elongation.*

"Other parameters enter into the relationship," Philipchuk explains, "and their influence is expressed in this equation:"

$P_e = K_m f$ (% elong., temperature, medium, explosive)

where:

P_e	= % plasticity by explosive forces
% Elong.	= % elongation (mechanical property)

Temperature	= temperature of metal
Medium	= medium used for force transmission
Explosive	= type of explosive
K_m	= constant for the metal

Each of these functions plays an important part in determining the plasticity which can be expected when explosive forces are applied to a specific metal. Each must be thoroughly investigated for any given family of metals.

It will be noted in the equation above that there is a "K_m" factor—a constant for the metal. It is in the percent of elongation that K_m is established. National Northern utilized "convenient test conditions and one explosive," in Philipchuk's words, "to determine a working K_m."

The formula evolved by the testers was $P_e = K_m$ (% elong.).

Applied to aluminum alloys, here is how a K_m determination was made.

1. Temperature (ambient: 40-60 F), explosive, and medium (water) were held uniform.

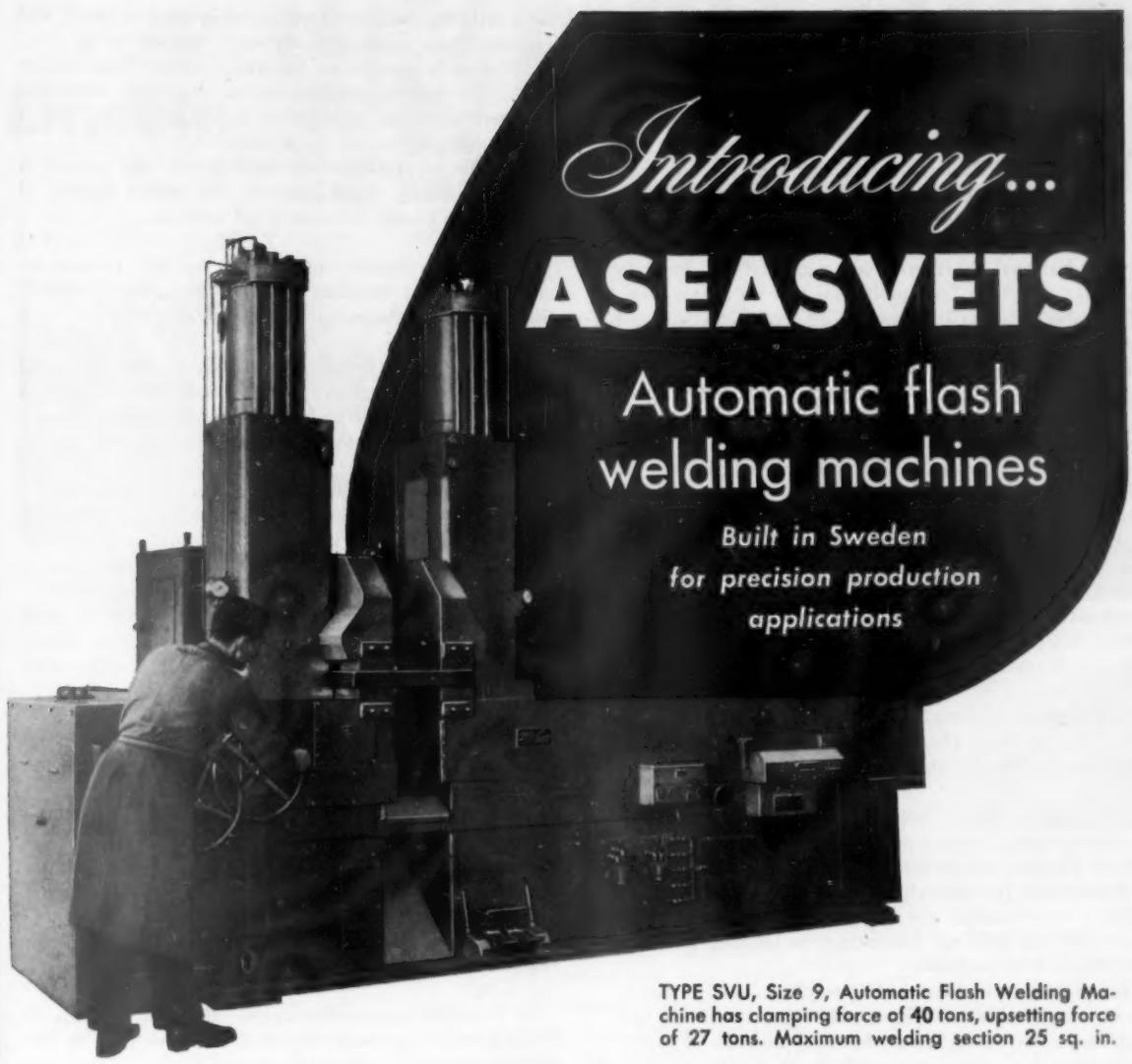
2. Alloys used were 6061-0 and 6061-T6 aluminum. Elongation of the former is normally 16.0%; of the latter, 10.0%.

3. Amount of deformation attained with explosive forces on the 6061-0 alloy was 39.0%; on the 6061-T6 alloy, 25.0%.

"The relationship of known test conditions," according to Philipchuk, "was, as previously stated, $P_e = K_m$ (% elong.). Thus, for 6061-0 it was $39.0 = K_m$ (16.0), or $K_m = 2.44$. For the 6061-T6 alloy, it was $25.0 = K_m$ (10.0), or $K_m = 2.5$."

From the above data, National Northern established a metal constant of 2.5 for aluminum, and confirmed it with tests under identical conditions on aluminum alloy 1100-0.

So that *WE* readers can more fully appreciate the extent to which metals are being successfully deformed by explosive forces, National Northern has released the following brief list. The number following the metal



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designation, if greater than 1.0, indicates that forming has occurred to a degree much greater than conventional methods could obtain.

Metal	K_m
Nickel	1.0
Stainless steel	1.1
Titanium	1.5
Plain carbon steels	2.3
Aluminum	2.5

(On the basis of tests still underway on other metal types, National Northern has suggested an indicated constant of 2.0 for both tool steels and for magnesium.)

Forging of metals by means of explosives demands techniques which vary from those used in forming. The high-rate stress application, however, is once again applied.

Preliminary hot and cold forgings of aluminum alloy wheels, turbine rotor shapes and connectors have been made. "They were sufficiently well received by the Air Material Command," says Philipchuk, "to warrant this group's sponsorship of a more thorough investigation."

Forgings of intricate shapes, or the use of alloys that are normally very difficult to forge—in short, forgings which are impossible or very expensive by conventional methods—are job types which National Northern will study. Cooperating with the firm on the A. M. C. program is Wyman-Gordon, Inc., of Grafton, Mass.

Explosive welding, which is being carefully investigated by the West Hanover firm, is still very much in its infancy—despite the persistence of rumors to the contrary.

After an accidental welding had occurred during an explosive metal-forming operation, Frank Bois, in the special projects department, brought this to the attention of Philipchuk. Immediately all conditions were noted and a rapid investigation was made into this phenomena to reproduce the welding. Thereafter, techniques for various metals were pursued.

In speaking with John A. Haynes, National Northern's sales manager, WELDING ENGINEER did uncover the fact that each metal family demands the application of highly individualized techniques, and that all welds are made on materials at ambient temperatures.

Further, *WE* was informed that preliminary welds at National Northern have been successful on such materials as aluminum to aluminum; aluminum to Inconel; aluminum to stainless steel; stainless steel to itself, and on aluminum sandwiched between stainless steel.

"The path appears to be open," states Vasil Philipchuk, "for welding any similar or dissimilar materials. The technique for each group is different, and that is why investigations are so necessary."

The use of explosives to bond metals can achieve a surface-to-surface bond without any actual fusion. It is therefore totally different from welding.

Specially valuable applications for this process include cladding; bonding of corrosion-resistant liners; lining irregular-shaped tubing, and locking this same type of tubing.

Experiments in bonding aluminum to steel and steel to itself in tubular shapes where a water-tight bond was required has been successful at National Northern. Bonding of steel plates and other variations are now under investigation.

The advantages of explosive welding or forming?

Basically, that these processes will handle jobs that can't be done by any known conventional means. Costs are still prohibitive insofar as welding by explosives is concerned, but if the experiments at National Northern (as well as at other interested firms) continue to meet with success, perhaps the regular implementation of explosives in creating a true fusion weld will one day soon be a reality.

Of course there are other advantages to be recognized in explosive welding and forming, and among the the most notable of these are:

1. Only one die is needed for welding or forming by means of high-explosive charges.

2. Extremely close tolerances can be held; even without a die, National Northern succeeded in maintaining a ¼-in. tolerance in one test series on forming steel.

3. There is no spring-back—a part subjected to an explosive charge for forming remains exactly as the die shapes it.

4. Physical characteristics of metal explosively formed or welded are improved. National Northern officials admit that some firms presently engaged in similar research feel that these characteristics remain unchanged. But the West Hanover firm, on the basis of its innumerable tests, is confident that its own appraisal—*i.e.*, metal is work-hardened by the blast—is correct.

WELDING RETURNS VULCAN'S HAMMER

THE FORGING HAMMER slowly rose to the top of its stroke, hung suspended for a moment, then plunged downward. But for once the ram-type hammer failed to do its work. It had cracked 8 in. deep along its full 37½-in. length.

Maintenance crews at the scene of the big break—Schmitt Steel Co., Portland, Ore.—sized up the repair job. They knew they could put the damaged head in a shaper and chip away the metal with an air hammer and chisels to ready it for welding. But the time and expense involved ruled this out.

Then someone suggested the use of an arc-air torch. This tool, they felt, could gouge out the necessary 2-in. width in the high-carbon steel quickly and efficiently. Using an Arcair Co. torch and ⅜-in. copper-clad electrodes on d-c at 270 amp reverse polarity, they wrapped up the job in 2½ hours. Total cost?—$8.62 for the 56 electrodes used.

A few months later, the crew was faced with another cracked hammer. This time there was no hesitation. Economy and speed ruled for arc-air gouging.

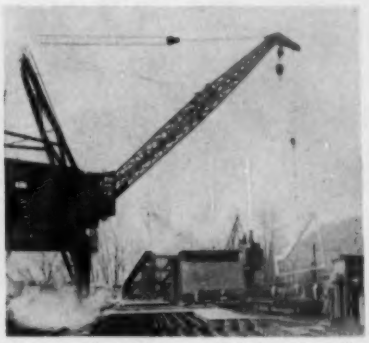
WELDING nears completion on 8-in. deep, 37½-in. long crack in the hammer.

Lincoln

WELDYNAMICS

NEWS ABOUT ARC WELDING AT WORK CUTTING COSTS

A "Squirt" Welder welds heavy plate in 1/4 the time.



Structural members are fabricated on the ground with Jetweld, then welded into sub-assemblies.

Jack Evans, General Foreman at Wiley, sparked a cost reduction program that succeeded.

WAR AGAINST HIGH COSTS NETS BARGE BUILDER 75% BONUS

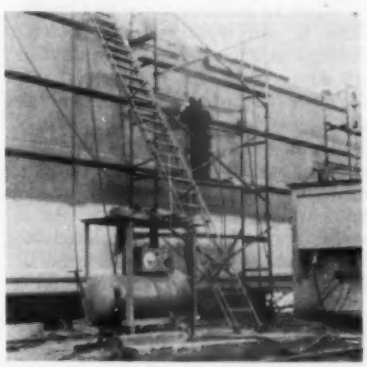
The Wiley Manufacturing Company of Fort Deposit, Maryland, builder of welded barges and large custom built cranes, initiated a cost reduction program that resulted in real savings.

Stanley Welsh, general superintendent, and J. J. Evans, general foreman, faced with ever rising labor costs, decided bold action was necessary if the company was to keep prices competitive. Since welding is the largest single operation in the Wiley yards it was only logical that they should look for a way to reduce welding costs first.

Enlisting the aid of Joe Gulley, a Lincoln welding engineer out of Lincoln's Baltimore office, the Wiley men began a detailed survey of their welding procedures and processes.

Mr. Gulley assisted Mr. Evans and his weldors to analyze the methods and electrodes used for welding sub-assemblies and for joining the sub-assemblies to the main structure. It was found that by positioning the smaller units iron-powder Jetweld electrodes could be used and speed increased considerably.

The jack-pot, though, was won by switching to semi-automatic for welding of heavy plate. By using a Lincoln "Squirt" welder propelled on a gas cutting buggy, Wiley is able to weld heavy plate, up to ¾ inch, in ¼ the arc time previously required to weld it manually.



Welded units form the barge on the ways.

Mr. Evans states that these savings are made even greater because very little plate preparation is necessary. Bevel is eliminated in plate up to ½" and weld cleaning is greatly simplified. The resulting welds are better, too, than can be made manually.

The result—a 75% saving in arc time on this operation!

Although no overall cost figures were immediately available, Mr. Evans estimated that they had been able to reduce total welding costs by at least one third.

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"Our only previous experience with aluminum welding had been a trial order for two boats of the same type. Our customer was so impressed with their performance that he immediately ordered a whole fleet.

"Prior to building these test boats, three of our welders had received training at Alcoa's New Kensington job shop. Now this really paid off. We found that aluminum could actually be welded at a faster rate than steel, and with relative freedom from warping and distortion. Aluminum's lighter weight eased handling problems and speeded assembly. As a result, the order was completed on schedule and the customer reports no trouble with the aluminum hulls."

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WASHINGTON
Seattle
Pacific Metal Co.
J. E. Haseltine & Co.
Spokane
J. E. Haseltine & Co.

WISCONSIN
Milwaukee
Machinery & Welder Corp.
Steel Sales Corp.

Carborundum Co. compiled 10 safety rules worth studying . . .

Grinding wheel

DO's

1—Do always handle and store wheels in a careful manner.

2—Do visually inspect all wheels before mounting for possible damage in transit.

3—Do check maximum operating speed established for wheel against machine speed.

4—Do check mounting flanges for equal and correct diameter. (Should be at least 1/3 diameter of the wheel and relieved around hole.)

5—Do use mounting blotters supplied with wheels.

6—Do be sure work rest is properly adjusted. (Center of wheel or above; no more than ⅛ in. away from wheel.)

7—Do always use a guard covering at least one-half of the grinding wheel.

8—Do allow newly mounted wheels to run at operating speed with guard in place, for at least one minute before grinding.

9—Do always wear safety glasses or some type of eye protection when grinding.

10—Do turn off coolant before stopping wheel to avoid creating an out-of-balance condition.

&

DON'T's

1—Don't use a wheel that has been dropped.

2—Don't force a wheel onto the machine or alter the size of the mounting hole—if wheel won't fit the machine, get one that will.

3—Don't ever exceed maximum operating speed established for the wheel.

4—Don't use mounting flanges on which the bearing surfaces are not clean and flat.

5—Don't tighten the mounting nut excessively.

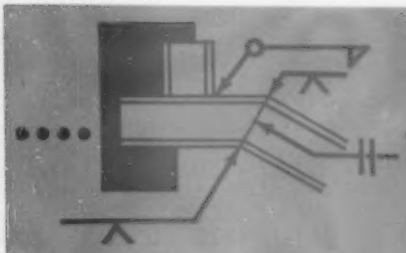
6—Don't grind on the side of the wheel unless wheel is specifically designed for that purpose.

7—Don't start the machine until the wheel guard is in place.

8—Don't jam work into the wheel.

9—Don't stand directly in front of a grinding wheel whenever a grinder is started.

10—Don't grind material for which the wheel is not designed.



the welding clinic

Here you may find the solution to your welding problems, whether they concern design, production, construction or maintenance welding. Submit your questions for answering on this page.

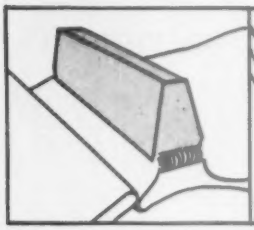


Fig. 1

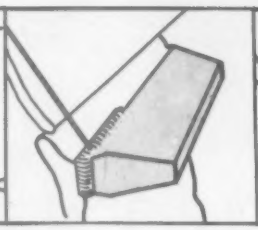


Fig. 2

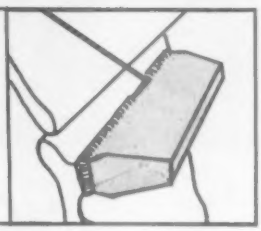


Fig. 3

How to properly weld grouser bars

Question:

What usually causes grouser bars on tractors to break and what welding procedure is recommended?

Answer:

There are four main causes of grouser bar breakage, according to International Steel Products Inc., Baltimore: use of wrong electrode; welding at wrong current; welding cold metal; and allowing cold air to blow on the weld.

Low hydrogen electrodes E6016 and E7016 give the best results when used at a current no higher than is necessary for good fusion. If current is too high, the alloying elements in the bars will contaminate the weld and cause it to crack.

At temperatures of 70 F, and higher, preheating is not necessary. If the temperature is between 40 and 70 F, preheating to 400 F is preferable, and if the temperature is below 40 F, preheating is necessary.

To begin the welding process, place the bar in upright position and grind uneven surfaces of the old bar. Torch cut new bar, being sure it is $\frac{3}{8}$ in. shorter than the old one. A 30-deg bevel should be left on each end. Position new grouser on old bar so $\frac{1}{8}$ in. remains on each end. This is to compensate for expansion and contraction of metals. The first weld bead should be drawn around the end of the joint (Fig. 1).

To weld side joints, place track so welding can be done in a horizontal position. Start weld at center of seam and work toward the end (Fig. 2). Then, weld from the opposite end to the center (Fig. 3). Such backstepping prevents overheating.

Reverse the track and repeat the welding procedure on the grouser's opposite side. If stringer beads are used, back-gouge and run a cover pass. Be sure all joints are welded and all weld craters filled.

If work must be done in the field, do not allow cold air to blow on the weld while it is being made.

Question:

In WELDING ENGINEER'S *last issue, the article on filler metals for joining by Orville T. Barnett stated that steels, cast iron, stainless steels, copper, nickel, lead and tin could be soldered with varying degrees of ease or difficulty. Could you expand on this?*

Answer:

Solderability depends on the wetting action of the base metal.

While not one of the easiest metals to solder, steels can be joined in this manner with proper flux and surface preparation. For most applications, 40-60 solders are used, however, 20-80 or 15-85 body solders are also common. Tinplates, terne plate and galvanized steel can also be joined.

Gray, malleable or nodular cast irons can be bonded if the free carbon is not wet by the solder. High tin-lead solders may be used, but this is a difficult method. White irons are almost never soldered.

High tin-lead wires containing at least 50% tin are recommended for joining stainless. Roughening highly polished surfaces and using active fluxes makes the job easier.

Low heat joining of aluminum, though not common, is being used more and more. Zinc-base solders alloyed with aluminum, silver, copper or nickel are recommended. Zinc content should be above 90%.

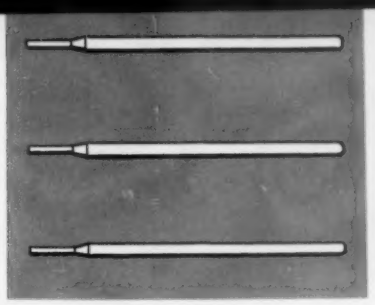
The tenacious oxide film on aluminum causes trouble. For this reason, very active organic-halide-borides or halides of zinc are best. The aluminum surface can be wet if properly fluxed or abraded.

Copper, using tin-lead solders, is one of the easiest metals to bond. However, soldering copper alloys becomes more difficult in this order: copper, bronze, brass, cupro-nickel, beryllium-copper, silicon-bronze and aluminum-bronze.

Nickel and nickel alloys have intermediate solderability when used with tin-lead wire containing at least 50% tin. Corrosive fluxes are most commonly used. Because of the corrosion resistance, age-hardening or high temperature properties of many nickel materials, service conditions must be carefully considered if soldering is to do the job.

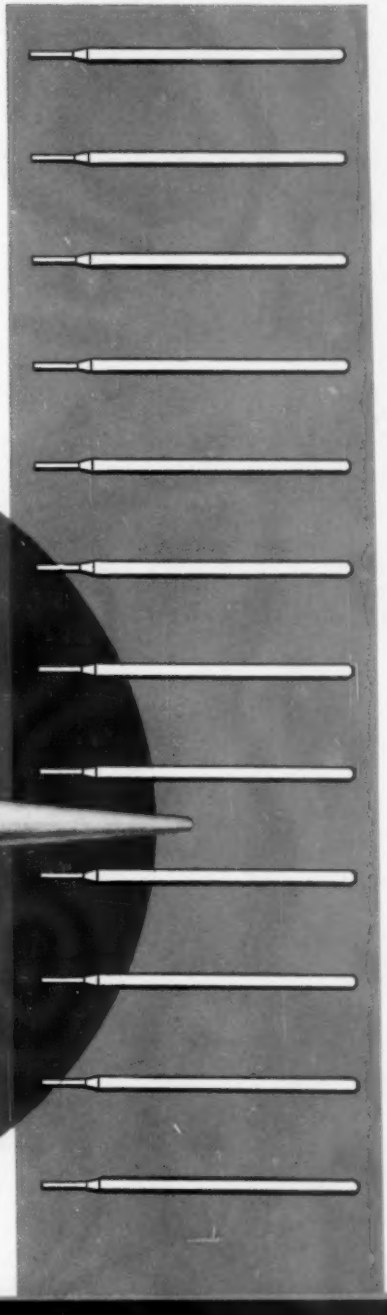
Lead is readily soldered and noncorrosive fluxes can be used. However, care must be taken not to melt the low melting point (621 F) lead base metal.

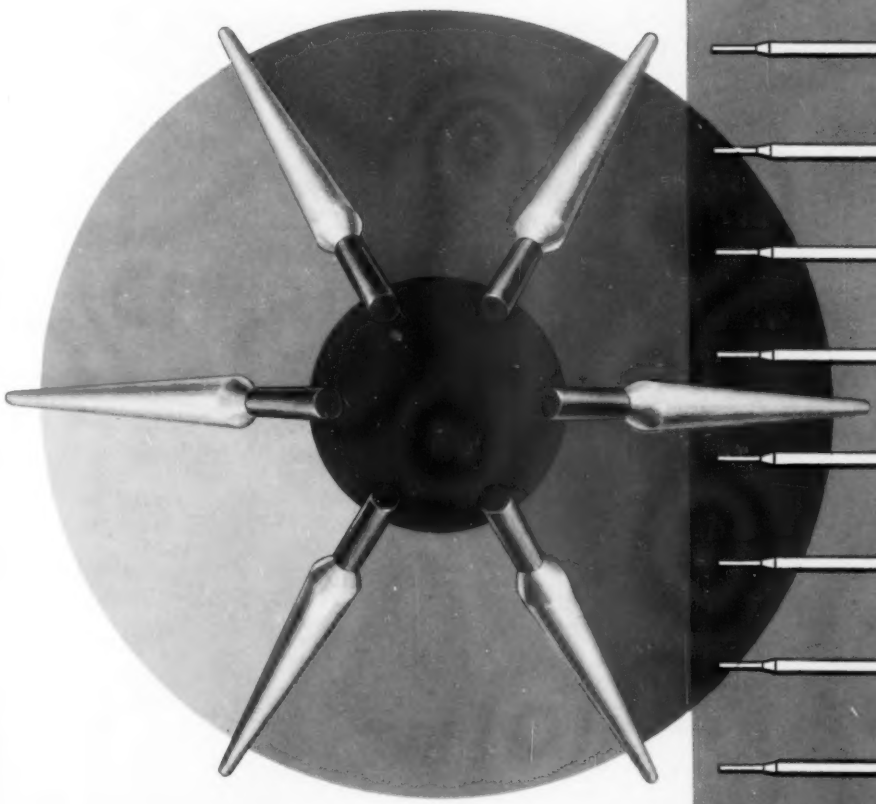
Tin and tin alloys (pewter) are easily soldered. Non-corrosive fluxes and 63-37 tin-lead solder give best results.



NOW... *from A. O. Smith*

NEW ELECTRODE CATALOG –KEYED TO NEW A.W.S. SPECIFICATIONS AND NEW NEMA COLOR CODE





HERE'S MORE DE

MILD STEEL

E 6010 **MIL-6010** **SW-10** **dc reverse**

All position. High cellulosic coating. Deep penetrating or cutting arc.

PROCEDURE: Horizontal and downhand welding: hold a medium to short arc, tilted 5° to 15° in direction of travel. Weave with a slightly oscillating motion, hesitating at the edges to insure proper fusion. Clean each bead before depositing next. Vertical and overhead welding: for best results hold electrode perpendicular to the work. Weaving of the electrode should be limited to allow only time enough for molten metal to set up.

	As Welded	Stress Relieved
Yield Point psi	59,200	53,800
Tensile Strength psi	71,150	67,600
% Elongation in 2"	29.9	34.5

X-Ray Quality

C	Mn	P	S	Si
.08	.47	.022	.026	.21

Complies with:
U. S. Navy — Spec. MIL-E-15599
A. B. S. — E 6010
U. S. Coast Guard
Lloyds Register of Shipping

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"
length	14"	14"	14"	18"	18"
amperes flat	110-130	140-160	170-190	220-250	240-300
amperes vertical	110-120	130-140	150-170		
amperes overhead	110-120	135-140	165-175		
volts	25-27	27-29	27-29	28-30	28-32

MILD STEEL

E 6011 **SW-14** **ac—dc reverse**

All-position cellulosic electrode. Produces easily co[illegible]olled forceful arc with deep penetration. "Hot strength" characteristics [illegible]rd against cracks.

PROCEDURE: Hold a medium to short arc tilted 5° to [illegible] in the direction of travel, with the electrode at an angle of 45° to ea[illegible]plate. Weave with slight oscillating motion, hesitating at the edges to i[illegible]re proper fusion. Clean each bead before depositing next.

	As Welded	Stress Relieved
Yield Point psi	65,500	55,100
Tensile Strength psi	75,500	66,400
% Elongation in 2"	26.5	33.5

X-Ray Quality

C	Mn	P	S	Si
.07	.40	.020	.025	.10

Complies with:
A. B. S. — E 6011
Lloyds Register of Shipping
U. S. Coast Guard

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"
length	12"	14"	14"	14"	18"	18"
amperes flat	70-80	100-130	130-160	155-190	175-220	225-260
amperes vertical	60-70	100-120	130-150	155-180		
amperes overhead	60-70	100-120	130-150	160-180		
volts	22-24	25-27	27-29	29-31	30-32	31-33

MILD STEEL

E 6020 **SW-37** **ac—dc**

An exceptionally high-speed iron oxide electrode for downhand and horizontal fillet welding. Produces less concave fillets and smooth finish pass welds at high speeds with high ductility and notch toughness.

PROCEDURE: Open arc with short arc for downhand welds, and open arc or drag technique for fillet welding. Tilt electrode in direction of travel to maintain slag-free puddle.

	As Welded	Stress Relieved
Yield Point psi	52,000	62,000
Tensile Strength psi	65,000	73,000
% Elongation in 2"	29.0	31.0

X-Ray Quality

C	Mn	P	S	Si
.09	.42	.015	.025	.25

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	7/32"	1/4"	5/16"
length	18"	18"	18"
amperes	280-310	300-350	370-410
volts	32-35	33-36	35-38

MILD STEEL

Not Classified **SW-18** **ac—dc straight**

A mineral type electrode for high-speed welding of sheet metal. Best electrode for welding vertically down. Also excellent for lap welds, horizontal fillet welds, skip welds and tacking for set-up, because of excellent restriking characteristics.

PROCEDURE: For flat or overhead welds—tilt electrode 5° to 15° in direction of travel. Hold very short arc, preferably using a drag weld technique. For welding vertically down use drag technique, tilting electrode 15° to 30° in direction of travel.

	As Welded	C	Mn	P	S	Si
Yield Point psi	57,000	.10	.42	.023	.022	.02
Tensile Strength psi	66,500					
% Elongation in 2"	23.5					

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"
length	14"	14"	14"	18"
amperes flat	110-140	130-160	200-240	260-310
amperes vertical down	120-150	140-180	210-250	
amperes overhead	110-140	120-150	180-220	
volts	22-24	23-25	24-26	25-27

LOW HYDROGEN

E 9016 B3 **MIL 94-15** **SW-89** **ac—dc reverse**

A low hydrogen type electrode designed for welding 2.25% Cr-1.0% Mo steels. Outstanding for welding of high-pressure, high-temperature piping found in power houses.

PROCEDURE: Pre- and post-heat treatment to job specification. Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Important to clean crater before restriking. Restrike in center of crater and move back toward previous bead. Then reverse direction.

Yield Point psi	81,550
Tensile Strength psi	95,800
% Elongation in 2"	22.0

X-Ray Quality

C	Mn	P	S	Si	Cr	Mo
.05	.65	.020	.029	.48	2.21	1.18

Complies with:
A. B. S. — Class E 9016 B3
U. S. Coast Guard — Class E 9016 B3
U. S. Navy — MIL-E-16589
MIL-94-15

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes flat	120-170	160-200	195-260
amperes vertical	90-120	110-140	140-170
amperes overhead	100-130	130-160	170-200
volts	23-24	24-25	25-26

LOW HYDROGEN

E 10016 G **SW-100** **ac—dc reverse**

The low hydrogen type coating is balanced to provide extreme ease in handling and excellent physical properties required for armor plate work, high ductility and unusually good impact values.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Important to clean crater before restriking. Restrike in center of crater and move back toward previous bead. Then reverse direction.

	As Welded
Yield Point psi	94,500
Tensile Strength psi	105,000
% Elongation in 2"	22.5

X-Ray Quality

C	Mn	P	S	Si	Mo	V	Ni
.07	1.00	.020	.022	.23	.42	.10	1.70

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes flat	120-170	160-200	195-260
amperes vertical	90-120	110-140	140-170
amperes overhead	100-130	130-160	170-200
volts	23-24	24-25	25-26

LOW ALLOY — HIGH TENSILE

E 7013 G **SW-85** **ac—dc**

An all-position, rutile electrode with excellent handling characteristics for welding high tensile steels.

This electrode has been used with great success on high tensile steels and on high pressure, high temperature chrome-moly piping.

PROCEDURE: Pre- and post-heat treatment in accordance with job specifications. For flat welds—tilt 5° to 15° in direction of travel. Hold medium length arc. For horizonal fillets—tilt 5° to 15° in direction of travel at angle bisecting the vertical and base plate. Hold medium length arc.

	As Welded
Yield Point psi	73,000
Tensile Strength psi	83,000
% Elongation in 2"	22.0

X-Ray Quality

C	Mn	Si	Mo
.09	.45	.45	.55

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes flat	120-130	150-165	190-220
amperes vertical	110-115	135-160	170-185
amperes overhead	110-120	145-165	170-185
volts	23-25	25-27	26-28

LOW ALLOY — HIGH TENSILE

E 8013 B2 **SW-88** **ac—dc**

An all-position, rutile electrode with excellent handling characteristics for welding high tensile steels.

This electrode has been used with great success on high tensile steels and on high pressure, high temperature chrome-moly piping.

PROCEDURE: Pre- and post-heat treatment in accordance with job specifications. For flat welds—tilt 5° to 15° in direction of travel. Hold medium length arc. For horizonal fillets—tilt 5° to 15° in direction of travel at angle bisecting the vertical and base plate. Hold medium length arc.

	As Welded
Yield Point psi	102,000
Tensile Strength psi	113,850
% Elongation in 2"	17.0

X-Ray Quality

C	Mn	Si	Cr	Mo
.09	.43	.50	1.45	.62

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes flat	120-130	150-165	190-220
amperes vertical	110-115	135-160	170-185
amperes overhead	110-120	145-165	170-185
volts	23-25	25-27	26-28

ETAILED INFORMATION ON

MILD STEEL

E 6012 **SW-11** **ac—dc straight**

High rutile electrode. Good on poor fit-up. For use in welding jobs calling for a "cold" E-6012 electrode. Outstanding in vertical down applications.

PROCEDURE: Hold a short arc or lightly touch coating to work, holding sufficient current so electrode does not stick, with the electrode tilted 5° to 15° in the direction of travel. For vertical welding, weld from the bottom up for heavy beads and down for small beads.

	As Welded	Stress Relieved
Yield Point psi	65,900	64,100
Tensile Strength psi	76,000	74,800
% Elongation in 2"	18.5	19.0

Complies with:
A. B. S. — E 6012
U. S. Coast Guard

C	Mn	P	S	Si
.07	.30	.022	.025	.20

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	1/4"
length	12"	14"	14"	14"	18"
amperes flat	70-80	120-140	160-185	200-240	280-330
amperes vertical	60-75	110-120	140-165	160-185	
amperes overhead	60-75	110-120	140-160	160-185	
volts	21-23	24-25	25-26	26-27	26-27

MILD STEEL

E 6012 **SW-12** **ac—dc straight**

A high rutile electrode — good on poor fit-up. Designed as a "hot" E-6012 electrode useful in applications where the upper end of the amperage range is employed.

Widely used for pipe booms • ship bulkheads • shaft tunnels • machinery base forms • electrical switch gears • tanks and headers • machinery of all types • steel houses.

PROCEDURE: Hold a short arc or lightly touch coating to work, using sufficient current so electrode does not stick. Tilt electrode 5° to 15° in the direction of travel. For vertical welding, weld from the bottom up.

	As Welded	Stress Relieved
Yield Point psi	65,900	64,100
Tensile Strength psi	76,000	74,800
% Elongation in 2"	18.5	19.0

C	Mn	P	S	Si
.07	.30	.022	.025	.20

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	1/4"
length	14"	14"	14"	18"
amperes flat	120-140	160-185	200-240	280-330
amperes vertical	110-120	140-165	160-185	
amperes overhead	110-120	140-160	160-185	
volts	24-25	25-26	26-27	26-27

E 6012 **SW-1**

A high rutile type electrode for heavy
is poor and high ductility and high
Can be used with high amperages.
Built-in toughness is one of its outstan
production work because higher amp
welding currents 30 to 40 amps higher
PROCEDURE: For flat welds tilt electrode
medium to short arc. For horizontal
direction of travel at angle bisecting ve
to short arc.

	As Welded	Stress Relieve
Yield Point psi	61,450	55,200
Tensile Strength psi	71,950	66,600
% Elongation in 2"	26.0	27.5

RECOMMENDED AMPERAGE

diameter	1/8"	5/32"
length	14"	14"
amperes	120-150	160-195
volts	25-27	26-28

IRON POWDER

E 70-6014 **SW-15 IP** **ac—dc**

A high-speed medium-heavy coated iron powder all-position electrode with sufficient penetration to assure root fusion and eliminate porosity in fillets. Designed for general-purpose welding where full positioning is not practical. Assures equal leg fillets to eliminate necessity of over-welding. Self-cleaning slag.

PROCEDURE: Open or drag technique may be used. Use medium to short arc on open arc and in both methods vary angle of electrode in direction of travel.

	As Welded	Stress Relieved
Yield Point psi	52,000	62,000
Tensile Strength psi	65,000	73,000
% Elongation in 2"	25.0	31.0
X-Ray Quality		

Complies with:
A. B. S. — E 70-6014
U. S. Coast Guard

C	Mn	P	S	Si
.09	.40	.015	.025	.23

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	1/4"	1/4"	5/16"
length	12"	14"	14"	14"	18"	18"	18"
amperes flat	70-100	120-150	160-200	230-270	290-330	340-400	400-440
amperes vertical	65-80	100-120	160-180	190-210			
amperes overhead	70-90	120-130	160-180	210-230			
volts	22-24	22-24	22-26	22-26	24-28	24-28	26-28

IRON POWDER

E 70-6024 **SW-44** **ac—dc straight**

A high-speed, heavy-coated, iron powder bearing, mineral-type electrode for high deposition rates on horizontal and downhand welding. Produces an equal-leg 45° fillet to eliminate overwelding. Excellent bead appearance with self-cleaning slag. Large fillets (up to 5/16") can be made with absolutely no undercut.

PROCEDURE: Drag technique should be used on horizontal and downhand fillets. Tilt electrode 5° to 10° in direction of travel and 40° to 50° from base plate. No weaving necessary.

	As Welded
Yield Point psi	75,000
Tensile Strength psi	87,500
% Elongation in 2"	25.0

Complies with:
A. B. S. — E 70-6024

C	Mn	P	S	Si
.09	.74	.030	.020	.80

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"
length	14"	14"	18"	18"	18"
amperes	150-180	180-220	250-280	300-340	350-400
volts	33-35	34-36	36-38	37-39	38-40

E 70-6016 **MIL-7016**

A lime ferritic electrode particularly
sulphur content and steels of poor we
alloy and high carbon steels without
enameled after welding. In many ca
and similar problems encountered wi
PROCEDURE: Tilt electrode 5° to 15° in
Use weaving or beading technique.
in center. Move back toward previou
continue.

	As Welded	Stress Relie
Yield Point psi	64,450	63,150
Tensile Strength psi	74,300	72,350
% Elongation in 2"	32.0	32.5

C	Mn	P	S	Si
.08	.79	.021	.017	.23

RECOMMENDED AMPERAGE

diameter	3/32"	1/8"	5/32"
length	12"	14"	14"
amperes flat	80-100	120-170	160-
amperes vertical	70-100	90-120	110-
amperes overhead	70-100	100-130	130-
volts	22-23	23-24	24-

LOW HYDROGEN

E 11015 G **SW-91** **dc reverse**

For all-position welding of Carilloy T-1 steel and high-tensile steels such as armor plate and other heat treated steel requiring high notch bar impact values.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Weaving or beading technique. Restrike in center of crater and move back toward previous bead. Then reverse direction.

	As Welded	Stress Relieved*
Yield Point psi	100,000	100,000
Tensile Strength psi	110,000	112,000
% Elongation in 2"	22.0	20.0
Keyhole Charpy ft. lbs. @ —65 F	32.0	26.0
V-Notch Charpy ft. lbs. @ —65 F	23.0	24.0

*Stress relieved at 1150F for one hour, furnace cooled.

X-Ray Quality

C	Mn	Si	Ni	Mo
.05	.94	.39	3.0	.62

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"
length	14"	14"	14"	18"	18"
amperes flat	120-170	160-200	195-260	230-310	280-350
amperes vertical	90-120	110-150			
amperes overhead	100-130	130-160			
volts	23-24	24-25	25-26	26-27	26-28

LOW HYDROGEN

E 12015G **MIL-260-15** **SW-120** **dc reverse**

For armor plate and non-heat-treated cast armor and high tensile-low alloy steels. This electrode has a heavy, low hydrogen type coating that produces a weld metal of unusually high ductility in the as-welded condition.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Important to clean crater before restriking. Restrike in center of crater and move back toward previous bead. Then reverse direction.

	As Welded
Yield Point psi	114,000
Tensile Strength psi	123,500
% Elongation in 2"	20.5

X-Ray Quality

Complies with:
U. S. N. — MIL-E-986 — MIL-260

C	Mn	Si	Mo	V	Ni
.06	1.04	.34	.98	.27	1.76

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes flat	120-170	160-200	195-260
amperes vertical	90-120	110-140	140-170
amperes overhead	100-130	130-160	170-200
volts	23-24	24-25	25-26

E 70-6018 **MIL-7018**

An all-position electrode which combin
for welding difficult-to-weld steels,
handling, reduction of starting porosit
PROCEDURE: Tilt electrode 5° to 15° in
beading technique, cleaning craters b
ahead of crater and move back to pre

	As Welded	Stress Relie
Yield Point psi	70,000	65,000
Tensile Strength psi	82,500	77,000
% Elongation in 2"	33.0	33.0

Stress relieved at 1150 F

X-Ray Quality

C	Mn	P	S	Si
.08	.72	.013	.020	.80

RECOMMENDED AMPERAGE

diameter	3/32"	1/8"	5/32"
length	12"	14"	14"
amperes flat	90-110	120-160	190-220
amperes vertical	70-90	110-140	130-170
amperes overhead	80-100	120-140	130-170
volts	19-23	20-21	21-22

LOW ALLOY — HIGH TENSILE

E 9010 G **SW-95** **dc reverse**

For maintenance and repair work particularly where rust, paint and scale are present. Will burn through rust, paint and scale when most other electrodes fail.

PROCEDURE: Horizontal and downhand — hold medium to close arc, with electrode tilted 5° to 15° in direction of travel. Weave with oscillating motion hesitating at edges. Clean each bead. Vertical and overhead welding — hold electrode perpendicular to work. Weaving should be limited to allow only time enough for set up.

	As Welded	Stress Relieved
Yield Point psi	91,500	87,650
Tensile Strength psi	102,500	98,150
% Elongation in 2"	16.0	18.5

X-Ray Quality

C	Mn	P
.12	.65	.02
S	Si	V
.025	.30	15

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes flat	110-120	140-160	170-180
amperes vertical	110-120	130-140	140-160
amperes overhead	110-120	130-140	140-170
volts	25-27	26-28	27-29

LOW ALLOY — HIGH TENSILE

E 12020 G **SW-101** **ac—dc straight**

A mineral type of electrode for both deep groove welding and positioned and horizontal fillet welds in high-tensile steels.

PROCEDURE: Preheat to 350° to 450°F and maintain this temperature until welding is completed. Immediately follow with stress relieving or complete heat treatment as required. For flat welds—tilt 5° to 15° in direction of travel. Hold short to medium arc. For horizontal fillets—tilt 5° to 15° in direction of travel bisecting the vertical and base plate. Hold short arc.

	As Welded	Stress Relieved	Heat* Treated
Yield Point psi	111,300	124,400	124,450
Ten. Strength psi	129,400	131,850	133,150
% Elong. in 2"	14.5	17.5	17.5

*Heat Treatment—Heat at 1650 F for 2 hours, oil quench, temper at 1165 F for 2 hours, air cool.

X-Ray Quality

C	Mn	P	S	Si
.12	.30	.022	.026	.20
Cr	Ni	Mo	V	
.42	1.71	.72	.16	

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	1/4"
length	14"	14"	14"	18"
amperes	120-150	160-185	200-230	280-310
volts	26-28	28-30	30-32	32-34

ES

SW-5

An inexpensive steel shielded-arc elec
ing any type of cast iron when machi
good arc characteristics permit use o
usual hardened zone along the line o
the admixture of cast iron.

Widely used for foundry repairing o
• build-up and repair of gray iron •
cracked cylinder heads and blocks.

PROCEDURE: Work should have oil, pai
welding.

diameter	
length	
amperes	
volts	

TION ON BEST SELLING

MILD STEEL

ac—dc straight

ed as a "hot" E-6012
nd of the amperage

tunnels • machinery
ders • machinery of

ting to work, using
ectrode 5° to 15° in
from the bottom up.

P	S	Si
.022	.025	.20

RANGE:

	¼"
	18"
40	280-330
85	
83	
7	26-27

MILD STEEL

E 6012 **SW-17** **ac—dc straight**

A high rutile type electrode for heavy production welding, where fit-up is poor and high ductility and high mechanical properties are desired. Can be used with high amperages.

Built-in toughness is one of its outstanding characteristics. Ideal for high production work because higher amperage can be used. It is used at welding currents 30 to 40 amps higher than ordinary E 6012 electrodes.

PROCEDURE: For flat welds tilt electrode 5° in the direction of travel, hold medium to short arc. For horizontal fillets tilt electrode 5° to 10° in direction of travel at angle bisecting vertical and base plate. Hold medium to short arc.

	As Welded	Stress Relieved
Yield Point psi	61,450	55,200
Tensile Strength psi	71,950	66,600
% Elongation in 2"	26.0	27.5

C	Mn	P	S	Si
.07	.35	.021	.027	.10

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"
length	14"	14"	14"	18"	18"
amperes	120-150	160-195	210-275	260-340	290-400
volts	25-27	26-28	27-29	28-30	28-30

MILD STEEL

E 6012 **SW-29** **ac—dc straight**

A high rutile, high production electrode especially adaptable for welding where weld cracking is a problem. Also good for poor fit-up work.

PROCEDURE: May be used with either polarity on dc. Straight polarity, however, will permit slightly greater speeds with a lower spatter loss. For best results hold a short arc with the electrode tilted 5° to 15° in direction of travel. For vertical welding weld from the bottom up. Where a small bead is desired, welding may be done vertical down. Clean each bead before welding next pass.

	As Welded	Stress Relieved
Yield Point psi	65,900	64,100
Tensile Strength psi	76,000	74,800
% Elongation in 2"	17.5	19.0

C	Mn	P	S	Si
.07	.30	.022	.025	.20

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"
length	14"	14"	14"	18"	18"	18"
amperes flat	120-140	160-185	200-240	260-310	280-330	380-440
amperes vertical	110-120	140-165	160-185			
amperes overhead	110-120	140-160	160-185			
volts	24-25	25-26	26-27	26-27	26-27	26-28

IRON POWDER

ac—dc straight

mineral-type elec-
nhand welding. Pro-
ling. Excellent bead
to 5/16") can be made

ontal and downhand
and 40° to 50° from

s with:
E 70-6024

RANGE:

7/32"	1/4"
18"	18"
00-340	350-400
37-39	38-40

LOW HYDROGEN

E 70-6016 **MIL-7016** **SW-65** **ac—dc reverse**

A lime ferritic electrode particularly adaptable for welding steels of high sulphur content and steels of poor weldability. Also used for welding low alloy and high carbon steels without preheating, and steels that are to be enameled after welding. In many cases, it will solve cracking, porosity and similar problems encountered with regular mild steel electrodes.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Important to clean crater. Restrike in center. Move back toward previous bead. Then reverse direction and continue.

	As Welded	Stress Relieved
Yield Point psi	64,450	63,150
Tensile Strength psi	74,300	72,350
% Elongation in 2"	32.0	32.5

X-Ray Quality

Complies with:
U. S. N. Type MIL-7016, MIL-E-18038
A. B. S. — E 70-6016
U. S. Coast Guard

C	Mn	P	S	Si
.08	.79	.021	.017	.23

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"
length	12"	14"	14"	14"	18"	18"
amperes flat	80-100	120-170	160-200	195-260	260-310	280-350
amperes vertical	70-100	90-120	110-140	140-170		
amperes overhead	70-100	100-130	130-160	170-200		
volts	22-23	23-24	24-25	25-26	26-27	26-28

LOW HYDROGEN

E 7016G **SW-84** **ac—dc reverse**

A 1.0% nickel electrode with low hydrogen type coating, producing excellent manipulative characteristics and depositing sound, extremely ductile weld metal. The bead is uniform and slag is easily removable.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Very important to clean crater before restriking. Restrike in center of crater and move back toward previous bead. Then reverse direction and continue.

	As Welded	Stress Relieved
Yield Point psi	71,250	66,100
Tensile Strength psi	80,700	75,200
% Elongation in 2"	31.5	34.0

X-Ray Quality

C	Mn	P	S	Si	Ni
.08	.77	.015	.017	.20	.96

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	5/32"	3/16"	1/4"
length	14"	14"	18"
amperes flat	160-200	195-260	280-350
amperes vertical	110-140	140-170	
amperes overhead	130-160	170-200	
volts	24-25	25-26	26-28

LOW HYDROGEN

dc reverse

nd high tensile-low
n type coating that
y in the as-welded

avel. Hold short arc.
an crater before re-
ck toward previous

Ray Quality

with:
MIL-E-986 — MIL-260

ANGE:

	3/16"
	14"
	195-260
	140-170
	170-200
	25-26

LOW HYDROGEN IRON POWDER

E 70-6018 **MIL-7018** **SW-47** **ac—dc reverse**

An all-position electrode which combines the advantages of low hydrogen for welding difficult-to-weld steels, and iron powder with its ease of handling, reduction of starting porosity and higher deposition rates.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Use weaving or beading technique, cleaning craters before restriking. Restrike electrode ahead of crater and move back to previous bead.

	As Welded	Stress Relieved
Yield Point psi	70,000	65,000
Tensile Strength psi	82,500	77,000
% Elongation in 2"	33.0	35.0
Stress relieved at 1150 F		

X-Ray Quality

Complies with:
A. B. S. — E 70-6018
U. S. Navy — MIL-7018, MIL-E-19322

C	Mn	P	S	Si
.08	.72	.013	.020	.80

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"
length	12"	14"	14"	14"	18"	18"	18"
amperes flat	90-110	120-160	190-220	230-270	290-330	340-380	425-475
amperes vertical	70-90	110-140	130-170	165-180			
amperes overhead	80-100	120-140	130-170	165-180			
volts	19-23	20-21	21-22	22-23	23-24	23-24	24-25

LOW HYDROGEN IRON POWDER

E 8018 C3 **MIL-8018** **SW-818** **ac—dc reverse**

A 1% nickel electrode combining the manipulative advantages of the iron powder low hydrogen coating with the correct balance of alloying elements to produce 80,000 psi minimum tensile with high ductility and notch toughness.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Use a weaving or beading technique, cleaning craters before restriking. Restrike electrode ahead of crater and move back to previous bead.

	As Welded	Stress Relieved*
Yield Point psi	80,000	79,500
Tensile Strength psi	91,500	91,800
% Elongation in 2"	22.0	20.0
V-Notch Charpy ft. lbs. @ —40 F	37.0	26.0

*Stress relieved at 1150 F for two hours, furnace cooled.

X-Ray Quality

C	Mn	Si	P	S	Ni	Mo
0.07	0.80	0.74	0.013	0.020	0.90	.18

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"
length	14"	14"	14"	18"	18"
amperes flat	120-150	180-220	230-270	290-320	330-370
amperes vertical	110-140	140-170	160-180		
amperes overhead	120-140	140-170	170-190		
volts	22-23	22-23	22-23	23-24	23-24

Y — HIGH TENSILE

ac—dc straight

lding and positioned

is temperature until
s relieving or com-
5° to 15° in direc-
tal fillets—tilt 5° to
d base plate. Hold

-Ray Quality

P	S	Si
.022	.026	.20

Ni	Mo	V
71	.72	.16

ANGE:

	1/4"
	18"
0	280-310
	32-34

CAST IRON

ES† **SW-5** **ac—dc reverse**

An inexpensive steel shielded-arc electrode designed especially for welding any type of cast iron when machinability is not required. Extremely good arc characteristics permit use of low amperage, thus reducing the usual hardened zone along the line of fusion. This low heat also lessens the admixture of cast iron.

Widely used for foundry repairing of malleable castings before anneal • build-up and repair of gray iron • cracked cast iron boiler sections • cracked cylinder heads and blocks.

PROCEDURE: Work should have oil, paint, grease and dirt removed before welding.

diameter	1/8"
length	14"
amperes	80-100
volts	21-23

CAST IRON

ENi **SW-Nickel** **ac—dc reverse**

A flux-coated electrode with a high-nickel core developed especially for cast iron when sound, machinable welds are required. The arc is exceptionally smooth with practically no flutter or spatter. Arc length is about the same as it would be for mild steel. Fluidity of the deposited metal is excellent. It "washes" evenly up against the sides of the joint, giving a strong fusion with low penetration and heat input. Slag is easily removed. Weld metal fuses thoroughly with the parent cast iron and will not spall out. Widely used for welding cracked castings • building up worn parts • filling out undersized areas • laying metal in faulty machine cuts and casting flaws.

PROCEDURE: Can be used in any position, including vertical and overhead. In cold weather, a moderate preheat of 150-250 F is desirable. When machining requirements are severe, a preheat of 500-700 F is recommended. It is also advisable to retard the rate of cooling by covering work with a blanket or other insulating material.

RECOMMENDED AMPERAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"
length	14" c.g.	14"	14"	14"
amperes	50-90	80-120	120-150	130-170

G A. O. SMITH ELECTRODES

MILD STEEL

E 6013 **SW-15** **ac—dc**

Finest universal, high-production electrode in industry with range of applications from light gauge to heavy plate. High heat and speeds can be used without undercut. Slag easy to clean and in vertical, overhead or flat work on heavy plate, the slag will peel off weld by itself.

PROCEDURE: For flat welds — tilt 5° to 10° in direction of travel. Medium arc. Horizontal fillets — tilt 5° to 15° in direction of travel at angle bisecting vertical and base plate. Arc of medium to short length. Vertical up — use a weaving "U" or "V" arc motion, hold medium to short arc. Overhead — use circular motion. Medium to short arc.

	As Welded	Stress Relieved
Yield Point psi	67,900	65,000
Tensile Strength psi	76,400	72,700
% Elongation in 2"	21.5	24.5

Complies with:
A. B. S. — E 6013
U. S. Coast Guard
Lloyds Register of Shipping

X-Ray Quality

C	Mn	P	S	Si
.10	.54	.020	.027	.45

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"
length	12"	14"	14"	14"	18"	18"	18"
amperes — flat	70-80	120-135	160-180	200-250	280-320	300-360	370-410
amperes — vertical	60-75	120-130	145-175	170-185			
amperes — overhead	60-75	120-135	150-180	180-200			
volts	21-23	23-25	25-27	26-28	27-29	30-31	30-32

MILD STEEL

E 6013 **MIL-6013** **SW-16** **ac—dc**

All position. Arc easy to handle with minimum of burn-through on thin gauges. Particularly adaptable for field applications on vertical down. Ideal on light gauges because of quick set-up and shallow penetration.

PROCEDURE: For flat welds — tilt 5° in direction of travel. Medium arc. Horizonal fillets — tilt 5° to 15° in direction of travel at angle bisecting vertical and base plate. For vertical down — tilt 30° in direction of travel. Hold short arc.

	As Welded	Stress Relieved
Yield Point psi	70,400	67,100
Tensile Strength psi	79,700	75,000
% Elongation in 2"	22.0	24.0

Complies with:
Lloyds Register of Shipping
Navy MIL-E-15599

X-Ray Quality

C	Mn	P	S	Si
.10	.42	.020	.028	.35

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	1/4"
length	12"	14"	14"	14"	18"
amperes — flat	60-80	120-140	150-170	190-230	290-320
amperes — vertical	60-80	110-140	140-170	175-195	
amperes — overhead	60-80	110-140	145-170	175-195	
volts	19-22	21-23	24-27	24-27	27-29

MILD STEEL

E 6020 **MIL-6020** **SW-35** **ac—dc**

A mineral type electrode often referred to as a "hot rod" because of its high speed in downhand, horizontal or positioned fillets, flat work and deep groove welding where extreme ductility is required.

PROCEDURE: For flat welds — tilt 5° in direction of travel. Hold short arc. For horizontal fillets — tilt 5° to 15° in direction of travel, bisecting vertical and flat plate. Hold short arc, allowing the electrode coating to lightly touch the bottom plate.

	As Welded	Stress Relieved
Yield Point psi	56,600	48,900
Tensile Strength psi	63,900	59,800
% Elongation in 2"	29.0	35.5

Complies with:
U. S. Navy — MIL-E 15599
A. B. S. — E 6020
U. S. Coast Guard
Lloyds Register of Shipping

X-Ray Quality

C	Mn	P	S	Si
.07	.32	.024	.027	.16

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"
length	14"	14"	14"	18"	18"	18"
amperes	130-155	165-185	200-240	27-310	300-350	350-410
volts	27-29	27-29	28-30	29-31	30-32	32-34

LOW HYDROGEN

E 7016 A1 **SW-79** **ac—dc reverse**

For all-position welding of carbon-moly and low alloy-high tensile steels. This 0.50 molybdenum electrode has a low hydrogen type coating. Arc action is quiet, stable and easy to handle. Bead appearance is uniform; slag is easily removable. Weld metal deposited is sound and extremely ductile.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Very important to clean crater before restriking. Restrike in center of crater and move back toward previous bead. Then reverse direction.

	As Welded	Stress Relieved
Yield Point psi	68,100	73,000
Tensile Strength psi	81,100	84,500
% Elongation in 2"	27.0	29.5

X-Ray Quality

C	Mn	P
.08	.60	.020
S	Si	Mo
.025	.29	.57

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	5/32"	3/16"	1/4"
length	14"	14"	18"
amperes — flat	160-200	195-260	280-350
amperes — vertical	110-140	140-170	
amperes — overhead	130-160	170-200	
volts	24-25	25-26	26-28

LOW HYDROGEN

E 8016 C1 **SW-81** **ac—dc reverse**

A 2.0% nickel electrode with a low hydrogen type of coating that produces a smooth bead with an easily removed slag. Used extensively in fabrications of nickel-bearing steels that require both high-tensile and high-impact values at low temperatures.

PROCEDURE: Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Important to clean crater before restriking. Restrike in center of crater and move back toward previous bead. Then reverse direction and continue.

	As Welded	Stress Relieved
Yield Point psi	73,200	75,900
Tensile Strength psi	82,400	85,100
% Elongation in 2"	24.5	29.5

X-Ray Quality

C	Mn	P
.08	.64	.011
S	Si	Ni
.024	.37	2.05

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"
length	14"	14"	14"
amperes — flat	130-150	165-195	225-250
amperes — vertical	120-130	145-165	
amperes — overhead	120-130	145-165	
volts	22-24	23-25	24-26

LOW HYDROGEN

E 8016 B2 **MIL-52-16** **SW-90** **ac—dc reverse**

This low hydrogen electrode was developed specifically for welding 1.25% Cr-0.5% Mo steels used in high-pressure piping in power houses and similar installations.

PROCEDURE: Pre- and post-heat treat according to job specification. Tilt electrode 5° to 15° in direction of travel. Hold short arc. Use weaving or beading technique. Important to clean crater before restriking. Restrike in center of crater and move toward previous bead. Then reverse direction.

	Stress Relieved
Yield Point psi	80,600
Tensile Strength psi	91,900
% Elongation in 2"	24.5

X-Ray Quality

Complies with:
U. S. N. — MIL-E-16589-52-16

C	Mn	P	S	Si	Cr	Mo
.08	.63	.014	.030	.35	1.20	.54

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	1/4"
length	14"	14"	14"	18"
amperes — flat	120-170	160-200	195-260	280-350
amperes — vertical	90-120	110-140	140-170	
amperes — overhead	100-130	130-160	170-200	
volts	23-24	24-25	25-26	26-28

LOW HYDROGEN IRON POWDER

E 10018 **MIL-10018** **SW-1018** **ac—dc reverse**

Combines the manipulative advantages of iron powder low hydrogen coating with the correct balance of alloying elements to produce 100,000 psi minimum tensile deposits with high ductily and notch toughness.

PROCEDURE: Tilt the electrode 5° to 15° in the direction of travel. Use a weaving or beading technique, clearing craters before restriking. Restrike electrode ahead of crater and move back to previous bead.

	As Welded	Stress Relieved
Yield Point psi	92,300	102,000
Tensile Strength psi	93,500	103,000
% Elongation in 2"	23.0	22.0
V-Notch Charpy ft. lbs. @ —65 F	46.0	41.0

Stress relieved at 1150 F for two hours, furnace cooled.

X-Ray Quality

C	Mn	Si	P
0.06	1.12	0.70	0.013
S	Ni	Mo	V
0.020	1.64	0.25	0.08

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"	7/32"	1/4"	5/16"
length	12"	14"	14"	14"	18"	18"	18"
amperes — flat	90-110	120-150	180-220	230-270	290-320	330-370	425-475
amperes — vertical	70-90	110-140	140-170	160-180			
amperes — overhead	80-100	120-140	140-170	170-190			
volts	19-23	22-23	22-23	22-23	23-24	23-24	24-25

LOW ALLOY — HIGH TENSILE

E 7010 A1 **SW-75** **dc reverse**

High-tensile, cellulosic coated electrode has cutting arc with deep penetration. For carbon-moly piping or castings where high tensile strength and creep resistance at high temperatures are desired.

PROCEDURE: Horizontal and downhand — hold medium to short arc with electrode tilted 5° to 15° in direction of travel. Weave with oscillating motion, hesitating at edges. Clean each bead. From bottom up, use whip or weave motion. From top down, use stringer bead or weave.

	As Welded	Stress Relieved
Yield Point psi	67,400	65,250
Tensile Strength psi	81,400	78,500
% Elongation in 2"	21.0	29.5

Complies with:
U. S. Navy — MIL-E-15716
A. B. S.
Lloyds Register of Shipping
U. S. Coast Guard

X-Ray Quality

C	Mn	P	S	Si	Mo
.09	.47	.015	.015	.30	.50

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	1/8"	5/32"	3/16"	1/4"	
length	14"	14"	14"	18"	
amperes — flat	110-130	140-180	170-190	240-300	
amperes — vertical	110-120	130-180	150-190		
amperes — overhead	110-130	140-150	160-170		
volts	26-27	27-28	28-29	29-32	

LOW ALLOY — HIGH TENSILE

E 7020 A1 **MIL-7020 A1** **SW-76** **ac—dc**

This high-speed molybdenum-bearing electrode specifically designed for downhand or horizontal fillet welding on low-alloy, high-tensile steels. It is used where tensile strength of 70,000-80,000 psi after stress relieving is needed.

PROCEDURE: For flat welds — tilt 5° to 15° in direction of travel and hold medium to short arc. For horizontal fillets—tilt 5° to 15° in direction of travel, bisecting the vertical and base plate. Hold short arc.

	As Welded	Stress Relieved
Yield Point psi	66,100	69,900
Tensile Strength psi	75,900	79,400
% Elongation in 2"	25.5	28.5

Complies with:
A. B. S. — E 7020 A1
U. S. Coast Guard
Lloyds Register of Shipping
U. S. Navy — MIL-E-15716

X-Ray Quality

C	Mn	P	S	Si	Mo
.15	.47	.025	.025	.15	.57

RECOMMENDED AMPERAGE AND VOLTAGE RANGE:

diameter	5/32"	1/4"	5/16"	
length	14"	18"	18"	
amperes	200-300	280-340	380-420	
volts	33-35	34-36	37-39	

CAST IRON

ENi Fe **SW-Nickel 55** **ac—dc reverse**

SW-Nickel "55" is a flux-coated special core wire which gives exceedingly strong ductile welds which prevent cracking and spalling out particularly applicable to high phosporous cast irons and ductile irons. It offers a stable arc in all positions, smooth bead contour, excellent "wash" and very easy slag removal.

PROCEDURE: Clean work of oil, grease and dirt. Grind off "skin." Use as low a welding current as is possible. Length of arc should be about the same as that used for mild steel electrodes. Flux should be removed from each crater before making restrike, and completely removed from each pass before starting subsequent pass. Use intermittent bead method to heat evenly. Peening moderately is useful in reducing stresses. The finished weld should be cooled slowly. A blanket or other insulating material can be used. Preheating is recommended only when maximum machinability is required; when the heat developed by welding may cause cracking in other parts of the casting or when the weld must withstand pressure. A normal preheat is about 600 F.

RECOMMENDED AMPERAGE RANGE:

diameter	3/32"	1/8"	5/32"	3/16"
length	14" c.g.	14"	14"	14"
amperes	50-90	90-120	120-150	130-170

Through research ...*a better way*

A.O.Smith
CORPORATION
WELDING PRODUCTS DIVISION
Milwaukee 1, Wisconsin

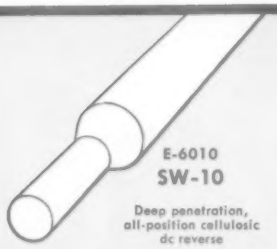
A. O. Smith INTERNATIONAL S. A. Milwaukee 1, Wis., U. S. A.

MW-230 9-58 LITHO U. S. A.

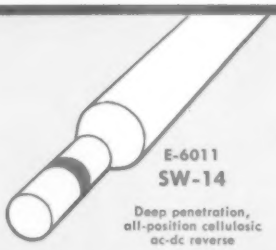
A. O. SMITH OFFER

Ch

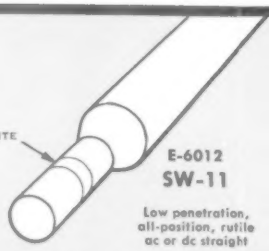
MILD STEEL



E-6010
SW-10
Deep penetration, all-position cellulosic dc reverse



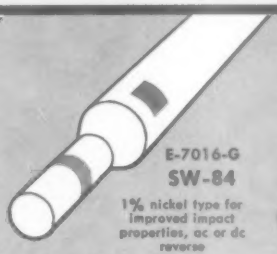
E-6011
SW-14
Deep penetration, all-position cellulosic ac-dc reverse



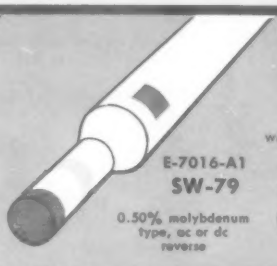
E-6012
SW-11
Low penetration, all-position, rutile ac or dc straight

LOW HYDROGEN

E-70-6016
MIL-7016
SW-65
For all-position welding of hard-to-weld steels, ac or dc reverse

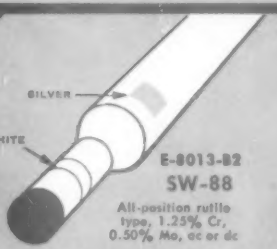


E-7016-G
SW-84
1% nickel type for improved impact properties, ac or dc reverse



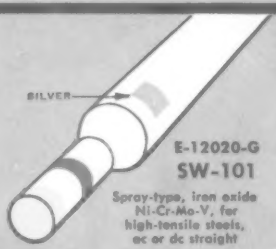
E-7016-A1
SW-79
0.50% molybdenum type, ac or dc reverse

E-7013-G
SW-85
All-position, rutile type, 0.50% Mo, ac or dc

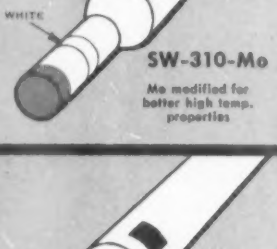


E-8013-B2
SW-88
All-position rutile type, 1.25% Cr, 0.50% Mo, ac or dc

E-9010-G
SW-95
Deep penetrating, all-position, cellulosic for maintenance, dc reverse

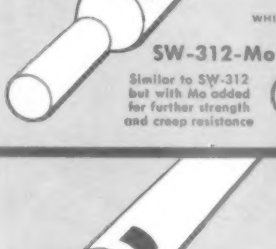


E-12020-G
SW-101
Spray-type, iron oxide Ni-Cr-Mo-V, for high-tensile steels, ac or dc straight

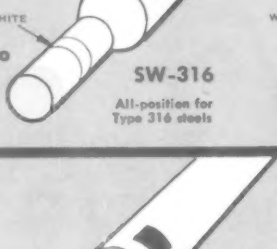


SW-310-Mo
Mo modified for better high temp. properties

SW-312
For welding Type 312 steels and dissimilar metals



SW-312-Mo
Similar to SW-312 but with Mo added for further strength and creep resistance



SW-316
All-position for Type 316 steels

SW-2Cr-Mo
For high-pressure steam lines operating at less than 1100 F.

SW-502
For high-temp. installations . . . 4-6% Cr steels

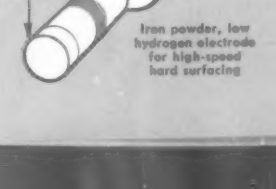
SW-151
For extra-high strength to weld aircraft-type alloy steels

SW-505
Designed specifically for high-temp. installations

DIAMONDWELD
AH-1
Iron powder electrode as base for hard surface overlays

DIAMONDWELD
AH-2
Moderate abrasion, heavy impact and base for overlays

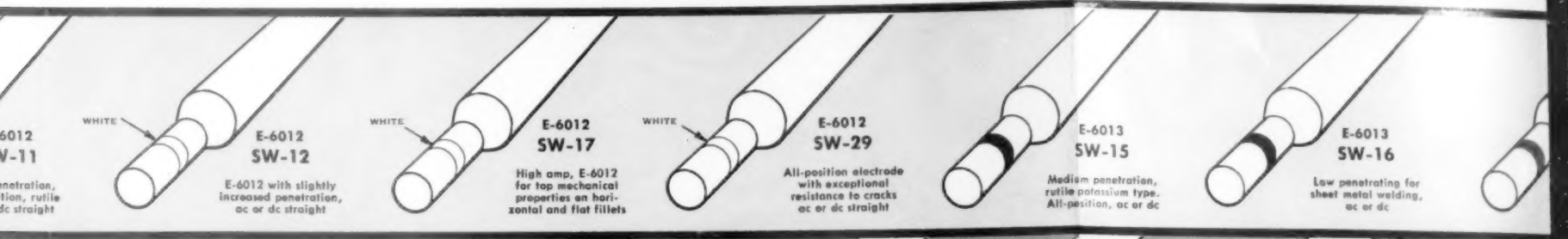
DIAMONDWELD
AH-3
For any ferrous base metal, for severe impact and abrasion resistance

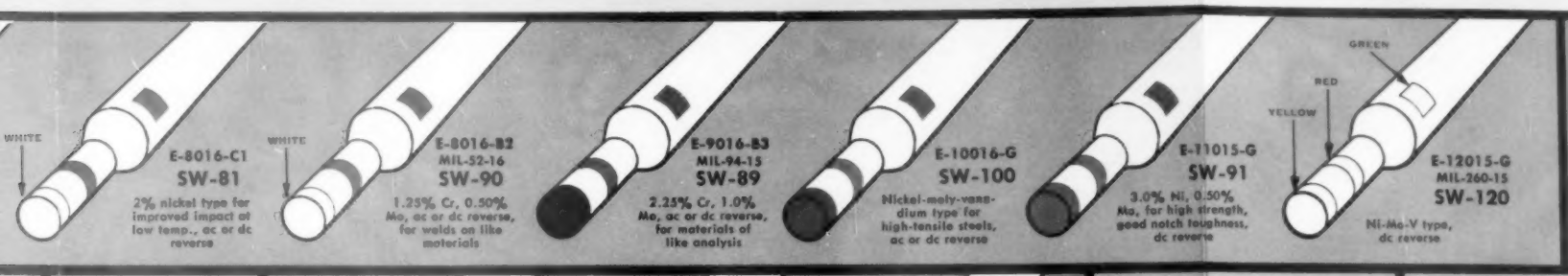


DIAMONDWELD
AH-4
Iron powder, low hydrogen electrode for high-speed hard surfacing

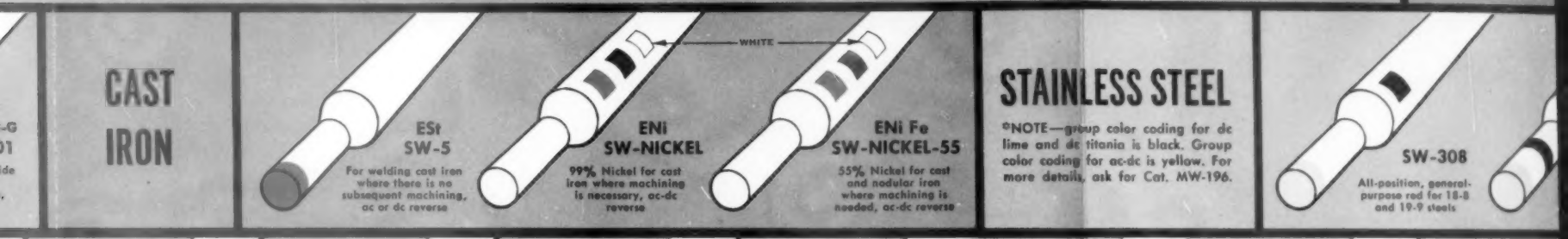
RS THE INDUSTRY'S MO ST COM R

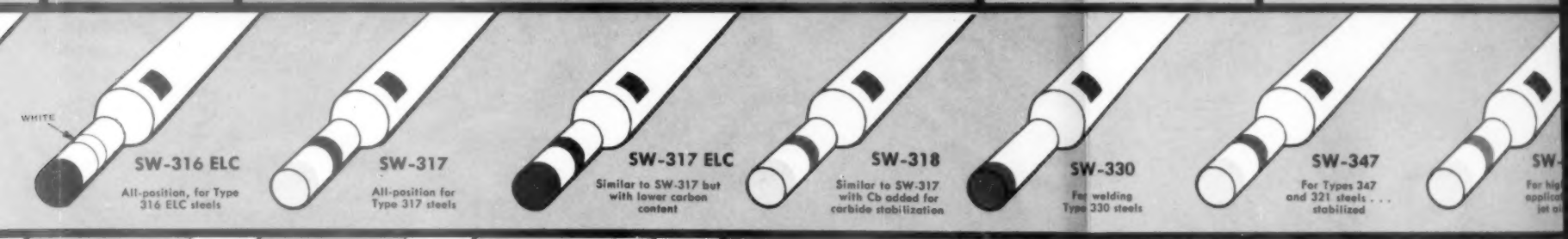
Choose from 87 basic types covering all maj

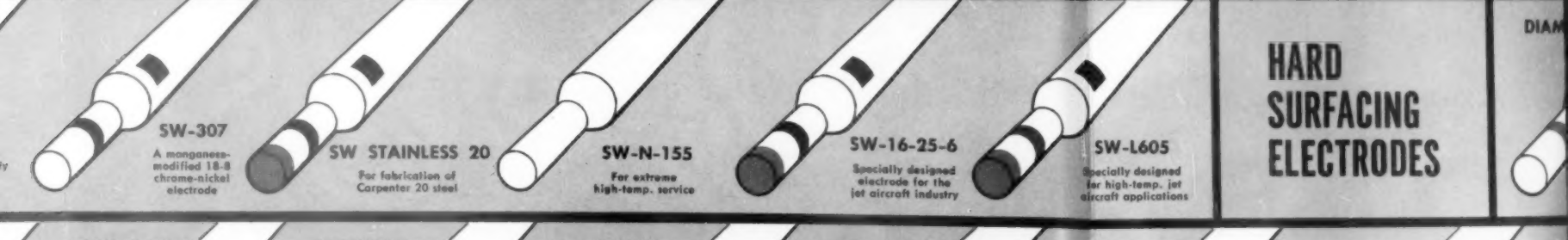


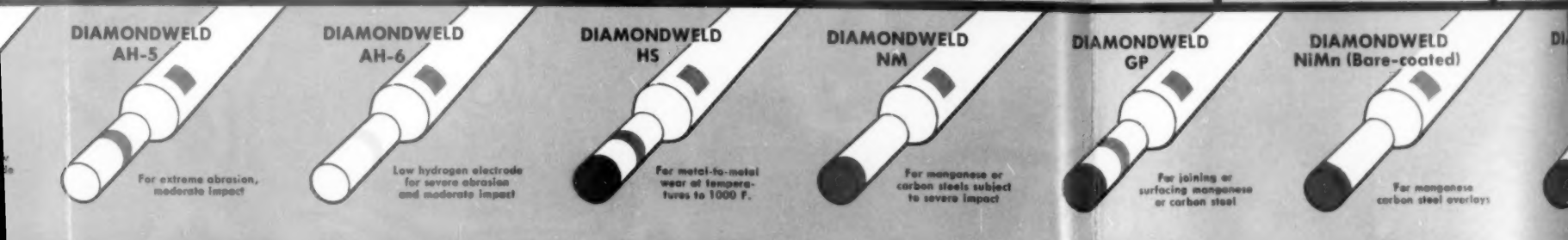


LOW HYDR
IRON POW


CAST IRON
ESt
SW-5
For welding cast iron where there is no subsequent machining, ac or dc reverse
WHITE
ENi
SW-NICKEL
99% Nickel for cast iron where machining is necessary, ac-dc reverse
ENi Fe
SW-NICKEL-55
55% Nickel for cast and nodular iron where machining is needed, ac-dc reverse
STAINLESS STEEL
*NOTE—group color coding for dc lime and dc titania is black. Group color coding for ac-dc is yellow. For more details, ask for Cat. MW-196.
SW-308
All-position, general-purpose rod for 18-8 and 19-9 steels

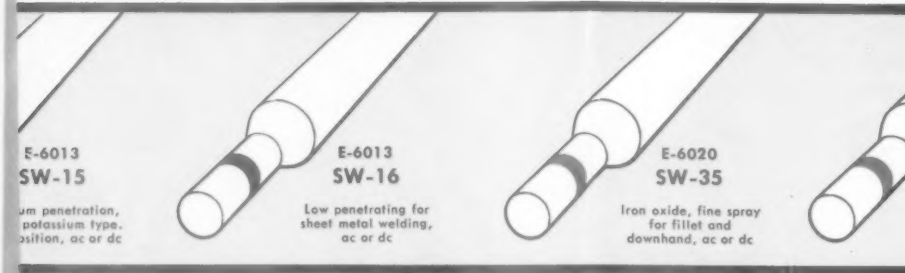

WHITE
SW-316 ELC
All-position, for Type 316 ELC steels
SW-317
All-position for Type 317 steels
SW-317 ELC
Similar to SW-317 but with lower carbon content
SW-318
Similar to SW-317 with Cb added for carbide stabilization
SW-330
For welding Type 330 steels
SW-347
For Types 347 and 321 steels . . . stabilized




DIAMONDWELD AH-5
For extreme abrasion, moderate impact
DIAMONDWELD AH-6
Low hydrogen electrode for severe abrasion and moderate impact
DIAMONDWELD HS
For metal-to-metal wear at temperatures to 1000 F.
DIAMONDWELD NM
For manganese or carbon steels subject to severe impact
DIAMONDWELD GP
For joining or surfacing manganese or carbon steel
DIAMONDWELD NiMn (Bare-coated)
For manganese carbon steel overlays

ST COMPREHENS

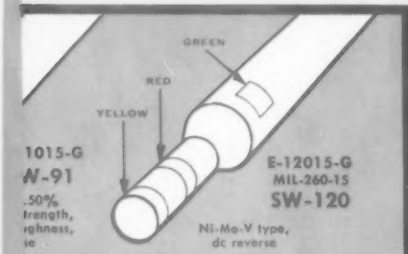
overing all major classi



E-6013
SW-15
um penetration,
potassium type.
sition, ac or dc

E-6013
SW-16
Low penetrating for sheet metal welding, ac or dc

E-6020
SW-35
Iron oxide, fine spray for fillet and downhand, ac or dc



1015-G
W-91
.50%
trength,
ghness,
se

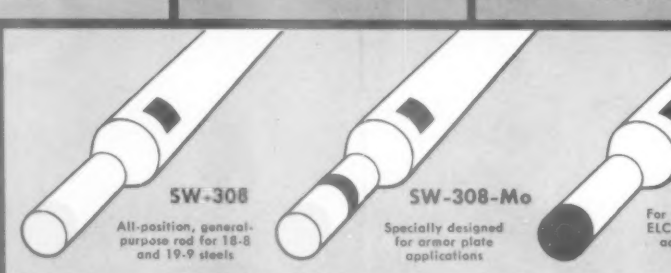
E-12015-G
MIL-260-15
SW-120
Ni-Mo-V type, dc reverse

LOW HYDROGEN
IRON POWDER

All-positio
difficult to
steels, ac-dc

LESS STEEL

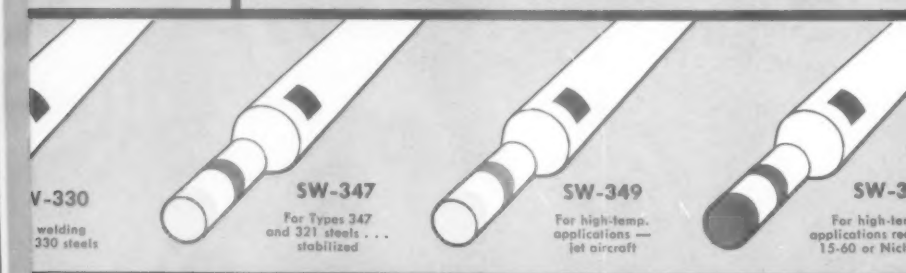
up color coding for dc
titania is black. Group
for ac-dc is yellow. For
ask for Cat. MW-196.



SW-308
All-position, general-purpose rod for 18-8 and 19-9 steels

SW-308-Mo
Specially designed for armor plate applications

For
ELC



V-330
welding
330 steels

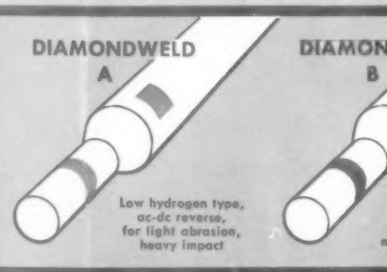
SW-347
For Types 347 and 321 steels . . . stabilized

SW-349
For high-temp. applications — jet aircraft

SW-3
For high-te
applications re
15-60 or Nick

SW-L605
pecially designed
or high-temp. jet
rcraft applications

HARD
SURFACING
ELECTRODES



DIAMONDWELD
A

Low hydrogen type, ac-dc reverse, for light abrasion, heavy impact

DIAMON
B

AMONDWELD
GP

For joining or surfacing manganese or carbon steel

DIAMONDWELD
NiMn (Bare-coated)

For manganese carbon steel overlays

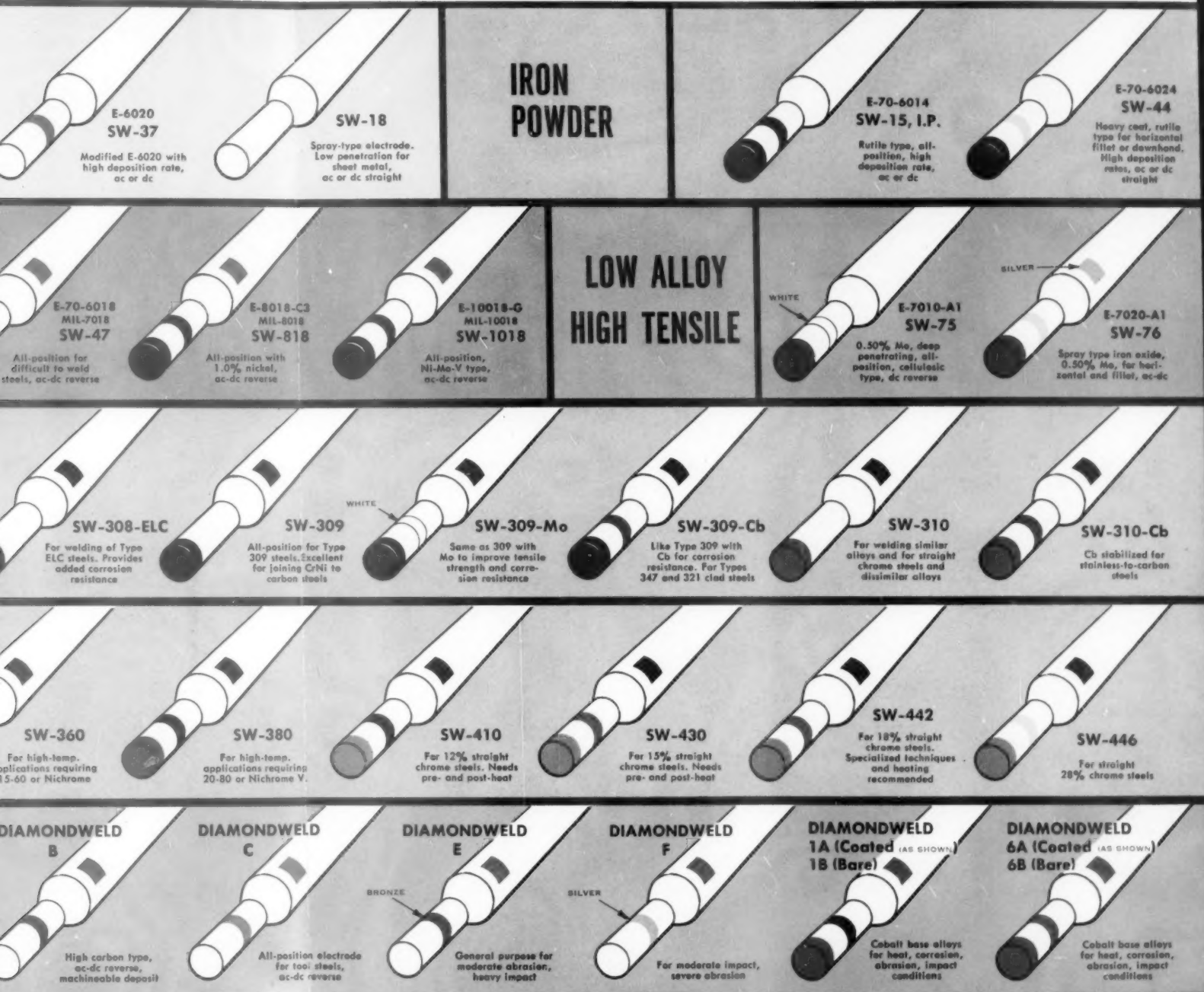
DIAMONDWELD
TM

For severe impact and severe abrasion

DIA

ISIVE LINE OF ELECTRODES

ssifications


E-6020
SW-37
Modified E-6020 with high deposition rate, ac or dc
SW-18
Spray-type electrode. Low penetration for sheet metal, ac or dc straight
IRON POWDER
E-70-6014
SW-15, I.P.
Rutile type, all-position, high deposition rate, ac or dc
E-70-6024
SW-44
Heavy coat, rutile type for horizontal fillet or downhand. High deposition rates, ac or dc straight
E-70-6018
MIL-7018
SW-47
All-position for difficult to weld steels, ac-dc reverse
E-8018-C3
MIL-8018
SW-818
All-position with 1.0% nickel, ac-dc reverse
E-10018-G
MIL-10018
SW-1018
All-position, Ni-Mo-V type, ac-dc reverse
LOW ALLOY HIGH TENSILE
WHITE
E-7010-A1
SW-75
0.50% Mo, deep penetrating, all-position, cellulosic type, dc reverse
SILVER
E-7020-A1
SW-76
Spray type iron oxide, 0.50% Mo, for horizontal and fillet, ac-dc
SW-308-ELC
For welding of Type ELC steels. Provides added corrosion resistance
SW-309
All-position for Type 309 steels. Excellent for joining CrNi to carbon steels
WHITE
SW-309-Mo
Same as 309 with Mo to improve tensile strength and corrosion resistance
SW-309-Cb
Like Type 309 with Cb for corrosion resistance. For Types 347 and 321 clad steels
SW-310
For welding similar alloys and for straight chrome steels and dissimilar alloys
SW-310-Cb
Cb stabilized for stainless-to-carbon steels
SW-360
For high-temp. applications requiring 15-60 or Nichrome
SW-380
For high-temp. applications requiring 20-80 or Nichrome V.
SW-410
For 12% straight chrome steels. Needs pre- and post-heat
SW-430
For 15% straight chrome steels. Needs pre- and post-heat
SW-442
For 18% straight chrome steels. Specialized techniques and heating recommended
SW-446
For straight 28% chrome steels
DIAMONDWELD B
High carbon type, ac-dc reverse, machineable deposit
DIAMONDWELD C
All-position electrode for tool steels, ac-dc reverse
DIAMONDWELD E
BRONZE
General purpose for moderate abrasion, heavy impact
DIAMONDWELD F
SILVER
For moderate impact, severe abrasion
DIAMONDWELD 1A (Coated (AS SHOWN) 1B (Bare)
Cobalt base alloys for heat, corrosion, abrasion, impact conditions
DIAMONDWELD 6A (Coated (AS SHOWN) 6B (Bare)
Cobalt base alloys for heat, corrosion, abrasion, impact conditions
DIAMONDWELD TC
For severe impact and severe abrasion

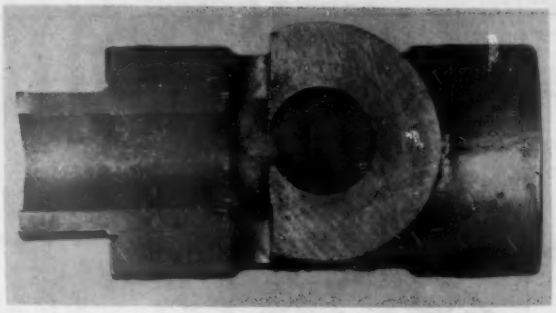
Plus automatic wires to meet every need —
A. O. Smith also offers a line of wires for automatic and semi-automatic welding for all types of steels. They include:

MILD STEEL — CO-85, CO-86. Designed particularly for carbon-dioxide shielded arc welding processes • **STAINLESS** — 308, 308 ELC, 309, 310, 316, 316 ELC, 330, 347, 321, 2 Cr Mo, 502, 410, 430, 446, 349, 312, Stainless 20 • **HARD FACING** — Gp 600, AH 100, NM 700, AH 500, AH 200, AH 300, AH 420.

Through research ... *a better way*

A.O.Smith
CORPORATION
WELDING PRODUCTS DIVISION
Milwaukee 1, Wisconsin

A. O. Smith INTERNATIONAL S. A. Milwaukee 1, Wis., U. S. A.



CUT-away section of high-pressure piping joint above had to be air-tight. Lengthy brazing area (from notch to notch at arrows) could not depend on capillary creep. With clad strip, rejects were virtually eliminated. A stamping die (right) had its life extended 17 times by use of the stripping; cost was reduced nearly 90%. Conventional brazed die is at right of the photo.

by **Allen G. Gilbraith**

High quality joints . . .

with brazing alloy clad strip

BRAZING ALLOY-CLAD strip is finding wide use in those brazing applications in which the fabricator is looking for 100% joint coverage, high joint strength, void-free deposits and reduced manufacturing costs.

These brazing strips are prepared by alloy diffusion through pressure and heat application over a base-metal surface. (Strips may be ferrous or nonferrous and the alloy may be placed on one or both sides.) The clad metal is then precision-rolled to exact gage, and cut to size. Thus, the fabricator can buy this composite strip according to his material and dimensional requirements.

Alloy can be diffused on low-carbon steels, copper, brasses, phosphor bronze, beryllium copper, Invar, Monel, nickel, nickel-silver, certain stainless steels, and precious metals. In fact, any combination of brazing alloy and base metal is possible if the alloy's melting range is above the base metal annealing temperature.

Clad stripping can be used in two ways: as a brazing shim, and as stock from which entire parts are stamped and formed. The strip is used as a shim when absolute control of alloy flow is mandatory, and when perfect joints are required.

Used as stock, the strip can be covered with alloy on either one or both sides. In this way the fabricator can mechanically preplace the alloy on the part to be brazed. Making blind joints or brazing several joints simultaneously (often required in electronic products), can be done easily.

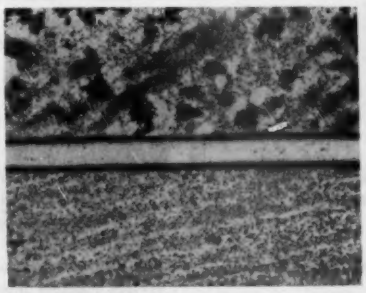
Stripping can be formed into numerous shapes and sizes. Available in coils or straight lengths, it can be stamped to form washers for butt and shear joints, or sleeves for tube and socket joints. Flat strips can be rolled into cylinders, cones, complex figures, or made into irregular shapes for inserts.

Sizes range up to 4 in. wide and down to 0.003 in. thick. In addition to being able to stipulate the side or sides he wants coated, a fabricator can also specify that the material be covered with *stripes* of alloy.

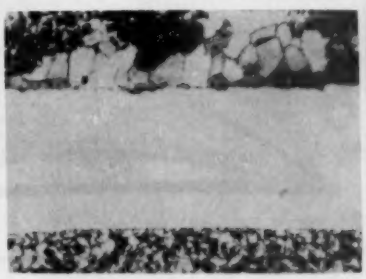
Brazing with clad strip can be done with torch, induction, dip and furnace facilities. However, the method usually chosen corresponds with that commonly used for the particular material and its thickness.

Full advantages of alloy-clad strip are seen when reviewing the disadvantages of conventional brazing.

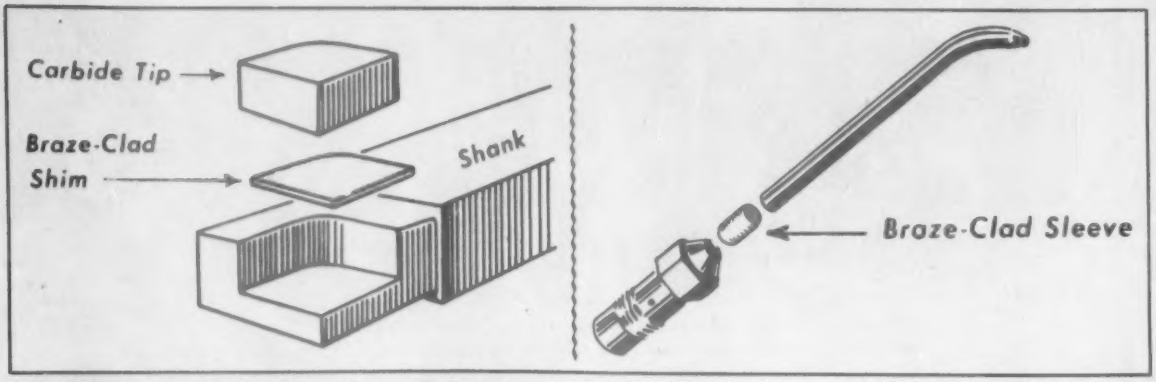
For example, joint lengths often hinder capillary creep. Tight fitups frequently present insufficient clear-



COMPARISON of plain silver brazing strip (left) and alloy-clad strip (right) shows high quality of the latter. Magnified 100 times,



the plain silver brazing had oxide islands and flux inclusions. Clad strip, magnified 500 times, contained no such defects.



CONVENTIONAL brazing of carbide tool tips calls for 5 pieces: tip, silver brazing alloy shim, copper shim, another alloy shim, and the shank. Clad strip replaces three shims, saves 50% of cleaning and fluxing time, and provides a stronger, neater weld.

WELDING torch tube assembly must be pressure tight. With conventional brazing, capillary action was necessary and removal of the unwanted fillet was expensive. Change to clad strip showed a 47% cost savings, reduced rejects and eliminated the fillet.

ance for alloy penetration. Preplacements are often impossible or impractical on blind joints. And when preplacements are used as strip or shim stock, imperfect joints occasionally result because as the alloy melts it pulls up into a ball before spreading over the metal's surface. The result: voids, oxide islands and flux inclusions.

When the brazing alloy is clad on strip, these disadvantages are eliminated. Alloy remains in place during the brazing cycle; there is no dependence on capillary creep; assembly is simplified by elimination of preplaced rings, washers or special shapes.

Finally, clad strip can braze joints of extraordinary length, and when making blind joints, gives 100% coverage.

Alloy flow can be closely controlled because alloy diffusion over the parent metal insures that it remains in place. Post-brazing removal of overflow, burrs or fillets is not necessary, and cleaning or fluxing operations are halved.

Elimination of capillary creep shortens the heating cycle, as well as lessens the tendency to overheat.

Because of these advantages, designs previously impossible can be used; high-speed, low-cost brazing is common; and unskilled operators can be employed.

However, the most important factor for any fabricator is the brazed joint strength. He wants a joint that will hold under the strains and stresses of on-the-job use.

Three factors determine the brazed joint's strength: (*1*) effective area of the braze; (*2*) continuity of the braze; and (*3*) uniform thickness of the braze. Alloy-clad strip meets these three requirements.

A comparison was made between alloy-clad strip and plain alloy strip on 303 stainless steel, 0.375 in. in diameter. Two butt joints were made with 0.010-in. alloy-clad strip (0.004-in. brass clad on both sides with 0.003-in. brazing alloy).

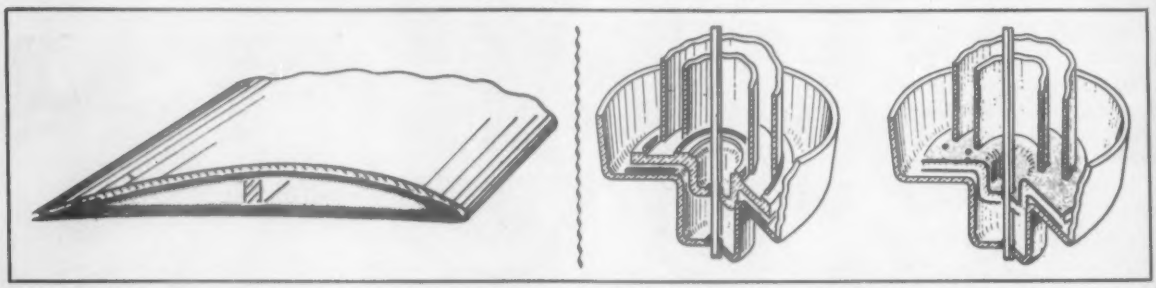
Two other joints were made with 0.015-in. alloy-clad strip (0.005-in. brass clad on both sides with 0.005-in. brazing alloy). A final joint was brazed with plain silver-alloy strip.

Pull tests were conducted on the five joints after brazing. Joints brazed with 0.010-in. clad strip tested to 56,000-72,000 psi. When brazed with the 0.015-in. clad strip, they had a strength of 53,000 to 69,000 psi. The plain silver brazed joints tested at a strength of only 23,000 psi.

After the testing, all fractured joints were examined microscopically. Those joints brazed with alloy-clad strip were free of voids or flux inclusions. However, the one joint brazed with plain silver alloy showed approximately 30% of its area either void or containing inclusions.

This relatively new brazing development effectively eliminates drawbacks of conventional silver brazing. In many cases, with practically no changes in setup, it will give stronger joints; 100% coverage; void-free, oxide-free deposits.

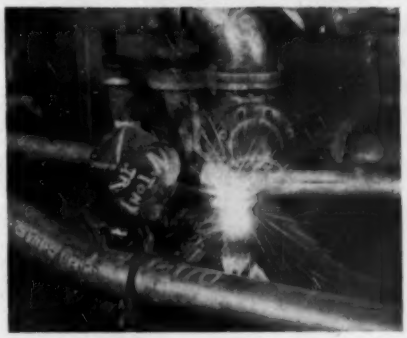
In other applications, with slight design changes, alloy-clad strip will speed normally slow, complicated operations; reduce rejections; and save time and money.



BLIND joints can be made with no guesswork about strength when using the clad strip. This is particularly important in aircraft, since parts can be lighter. The illustration shows a re-inforced hollow blade.

WHEN multiple joints must be made simultaneously, a single clad strip part can bond many smaller components. In the electronic tube shown, the strip does the work of 4 brazing alloy rings and one washer.

WHATEVER YOU WELD... WHEREVER YOU WELD ELECTRICALLY



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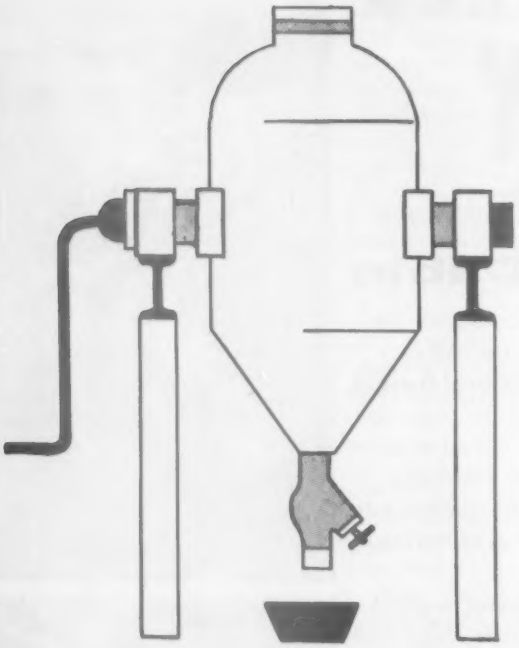
DIGESTER interior shows vertical walls completely overlayed. Approximately 1,400 sq ft of weld overlay was applied.

Just what the welding doctor ordered . . .

Stainless steel overlay coats an "ulcered stomach"



EACH Mig unit welds an area of about 120 deg of the digester circumference. Overlay is approximately 3/16-in. thick and can be deposited at the rate of 40 ipm. Another Mig unit (not shown) can rotate 360 deg during overlay application.

THESE WORDS are written on paper that, in another form, once churned inside a huge steel "stomach"—a digester.

In the paper and pulp industry, wood chips are fed into digesters to be cooked by gases and hot liquids. Pressures may be as high as 150 psi and temperatures may climb to 350 F.

Eventually, the carbon steel walls of these manufactured stomachs become thinned and pitted by corrosion and erosion. Sometimes operating pressures must be reduced, cutting down the flow of processed "food" to a paper-pulp-hungry manufacturing and business world. Possibly this localized or general thinning will lead to major digestive disorders—and the vessel may be condemned.

At one time, the life expectancy of a digester was 10 to 15 years. Process modifications, however, have led to increased thinning of digester

Correct Outline—Figure #1

Wrong Outline—Figure #2

SOAP-stone cutline should have no sharp angles (left) since these angles (right) are stress risers and may cause early service failures.

Figure #3

IRREGULAR depth of the defect should be followed (left). It is not necessary to build up overlay even with the inner wall surface.

walls—materially shortening life expectancy. Some digesters have been seriously affected in just two years of use.

Research pioneered by Crucible Steel Co. of America led to the idea of applying weld overlay to the vessels. To test this theory, the first overlay was manually applied in January, 1951, using type 308, 310 and 316 coated stainless steel electrodes. After more than six years, the weld overlay showed no evidences of further attack.

Today this proved weld overlay process is widely used—and digesters with as much as 800 sq ft of overlay surface have been manually protected. Automatic methods are used to completely overlay entire digesters.

Both the 310 and 316 electrode types have met with success.

Success of a weld overlay depends largely on contour of the weld deposit, particularly at the perimeter of the overlay. High-crown welds, it is thought, allow the turbulence of liquids to concentrate eroding action at these points. All crowns must be eliminated to prevent stress risers and the washing away of parent metal at the fusion line.

Tapered welds prevent both these conditions by allowing the liquid to flow freely over the welded junction thus preventing early failures.

Digesters are cylindrical or spherical. The cylinders range up to 12 ft in diameter and 52 ft long, while the spheres are sized to 29 ft in diameter. Walls in both may be as much as 2 in. thick. Weld overlay has been applied predominantly to cylindrical digesters.

For proper bonding of the overlay, the surface must be cleaned of loose scale by mechanical wire brushing, vibration descaling, or shot blasting. In pitted areas, descaling is particularly vital; eroded areas usually are clean enough for welding without elaborate surface preparation. Hand wire brushing removes powdery rust, and may be adequate. Shot blasting, however, provides assurance of absolute surface cleanliness.

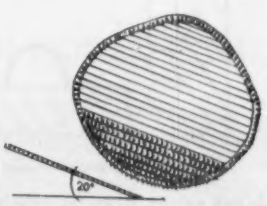
MIG welding gun is connected to a radiograph having an indexing feed screw. The adjusting screw feed regulates weld bead spacing while the radiograph travels on the ring table and propels the unit.

Where heavy, uniform scale exists intact adjacent to the defective area, it acts as a protective surface for the base metal and helps resist attack.

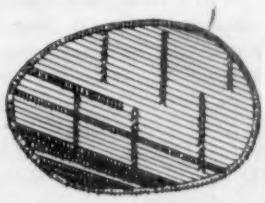
With soap-stone, outline the area to be overlayed, avoiding sharp angles which are stress risers. The weldor can place his initial perimeter weld bead directly on this soap-stone outline. (Because chalk or crayon may contain sulphur which may cause weld metal porosity, the initial weld bead should be about ½ in. inside this type of marking.)

Two small, flat perimeter weld beads are deposited—the first by welding (as fast as possible) vertically downward. Start at the top of the outline and direct weld movement downward until one-half of the outlined perimeter is complete. The other half should be completed the same way, traveling in the opposite direction.

The second perimeter bead should be applied directly inside the outer weld bead, so that it overlaps half of the initial deposit. This bead



Without Changing Location—Figure #4



Changing Location—Figure #5

SMALL defective areas can be overlayed without changing direction (left). On large defective areas, however, where changing location is necessary, the prime overlay should be placed in segments (right).

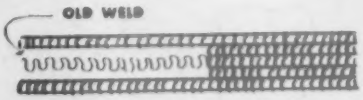


Figure #6

HORIZONTAL seams should have two small weld beads deposited on the soapstone line 1-in. above and below the original weld seam (above). For vertical seams, the same method is followed depositing the bead from top and bottom (right).

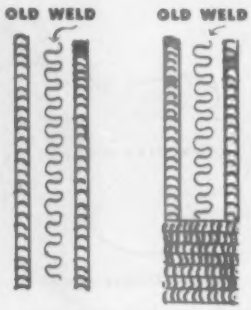


Figure #7

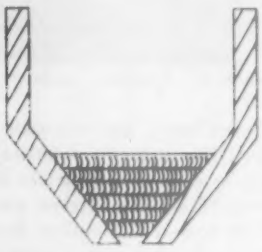


Figure #8

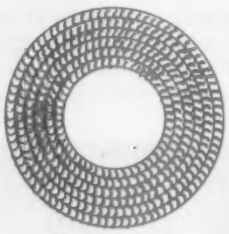


Figure #9

OVERLAY for cone welding should be started at the bottom, making one complete circumferential weld and continuing until complete (above, left and right).

should be applied more slowly, making it slightly heavier than the first and effecting a slightly tapered weld.

The perimeter weld bead prevents undercutting when starting or ending the prime weld overlay, and eliminates any tendency for excessive weld crowning. For the perimeter bead, 5/32-in.-diameter electrodes are recommended.

Apply the major weld overlay by starting at the bottom of the perimeter (using 3/16-in. lime or titania-coated stainless electrodes and working from left to right (or vice versa). Progress upward with each bead.

Overlay should be deposited by placing weld beads on an approximate 20-deg angle from the horizontal to get a 3/16-in.-thick minimum weld deposit—the most desirable. Welding should be started on the high side of the angle and sloped downward. A good rule-of-thumb in obtaining the 3/16-in. deposit is not to exceed a 21-in.-max. of linear weld deposit for every 14-in. electrode (3/16-in. diameter).

All metal-arc welding should employ a close arc and straight-forward motion without electrode oscillation.

The overlay should follow the irregular depth of the defect—build-up is unnecessary. No post-weld preparation is needed, but all slag should be removed.

When defective areas are small, enabling the weldor to stay in one position, he can deposit the prime weld overlay starting at one side of the perimeter and ending at the other. If the area is large, and he must move periodically, the prime overlay should be made in segments by placing single vertical-down weld beads at locations convenient to the weldor. Areas between the vertical-down beads are then filled in with weld metal on the horizontal plane.

On completion of the overlay, a small flat bead should be laid around the overlay's entire perimeter. This bead is made in the same manner as the initial perimeter beads, using 5/32-in.-diameter electrodes. It serves as a further aid to weld tapering, and eliminates irregularities and high-crowned weld shoulders developed when interlocking the prime overlay into the initial perimeter beads.

When only the original weld seam needs overlay, the area should be outlined with soap-stone parallel to the junction of the fusion line for both horizontal and vertical seams, using 5/32-in. diameter electrodes.

On horizontal seams deposit two small weld beads parallel to the seam 1 in. above and below the original seam. After completing the weld beads, the area between should be filled in with 3/16- or 5/32-in.-

Figure #10
Improper Weld

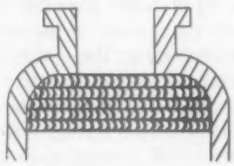
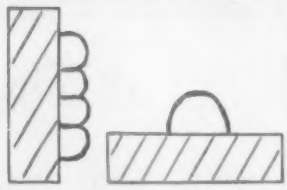
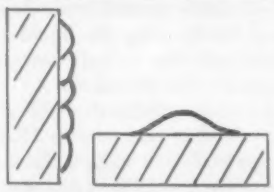


Figure #11
Proper Weld



High-Crown Weld—Figure #12



Tapered Contour Weld—Figure #13

DOME welding should be done in a semi-circular manner (top, left and right) interlocking each succeeding bead one-quarter distance into the preceding deposit. Eroding action and stress risers concentrate on high-crown welds (above, left), whereas tapered welds (above, right) prevent these conditions and permit liquids to flow freely over the weld joint.

A Cherry-Burrell milk-cooling tank with heat exchanger welded to the bottom.

Radiograph showing welding had flashed, leaving splattered metal spurs.

The tank had to be "Tops" —*Radiography pointed a way*

Milk handling and storage equipment has the most rigid health and sanitary requirements. The high quality and safety of milk must be protected. So, when this Cherry-Burrell farm milk cooling tank was developed, every precaution was taken to strive for perfection.

For example, the tube heat-exchanger welded on the bottom was radiographed to check for soundness. Early radiographs showed several places where the welding had splattered and formed spurs inside the tubing. This could have caused difficulties. So, the welding technique was altered and later radiographs proved the trouble removed.

Radiography is a great protector of quality. It can assure the welder and the foundryman that only good work leaves his shop. It saves time and money—helps build business. If you would like to know how it can help you, get in touch with your x-ray dealer or Kodak technical representative and talk it over.

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diameter electrodes on a straight horizontal plane. The 20-deg angle overlay method is not economically feasible in this case.

On vertical seams, two weld beads should be placed parallel to the original weld seam, 1 in. on either side. They should be deposited vertically downward, starting at the top. The area should be filled in on the horizontal plane in forward and backward motion. Slag can be removed when the electrode has been consumed.

To taper the deposit, two fast, vertical-down, flat weld beads should be placed at the shoulder on each side of the overlay. Again, 5/32-in.-diameter electrodes are recommended.

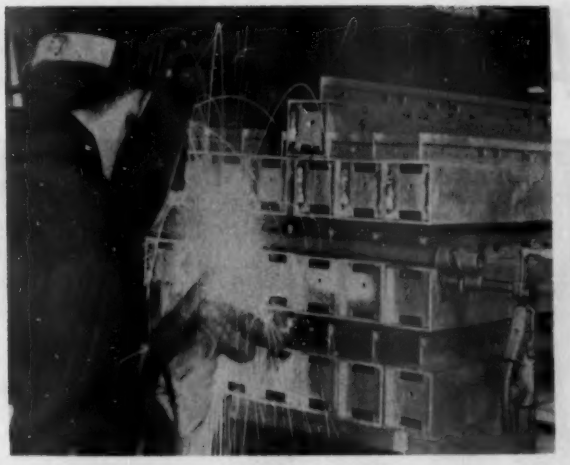
In repairing a cone, the overlay should be started at the bottom. One complete circumferential weld should be continued to completion, overlapping each bead one-half way into the preceding deposit. For this overlay, 3/16-in. electrodes should be used except for the last pass. Here, a 5/32-in. electrode will give a tapered deposit. In dome welding, the overlay should be deposited in semicircular fashion using 3/16-in. electrodes.

Usually, a few minutes after service begins in the boiling solution, a film forms on the surface of the base metal adjacent to the stainless overlay. This, apparently, increases resistance of the carbon steel and decreases the tendency for galvanic attack between the two metals.

Should there be any evidence of attack at the fusion line of the weld junction, an extension of the overlay should be applied by depositing a flat, tapered weld.

Mig or submerged-arc equipment in an automatic set-up may be used to deposit digester overlays. Both proccesses should apply the overlay horizontally—1/16-in.-diameter bare welding wire is used with the Mig process, and 5/32-in. bare wire with submerged-arc.

In string-bead fashion, the overlay is deposited at a rate of about 40 ipm, giving a minimum 3/16-in.-thick overlay. Each succeeding bead is lapped one-half way into the preceding deposit. The overlay follows the contour of the defect regardless of shape. Only one layer is required throughout the unit to arrest corrosive and erosive action.



WELDOR (at left) joins ends of mullion units in sequence. Mullions are first assembled, stacked horizontally and then clamped firmly for dimensional stability. Weldor (below) joins sides of wall units. Fifty window units are stacked on movable skids in preparation for series welding.

Clean wire nullifies Mig welding gremlin

by **Harry K. Tucker, Jr.**
All-State Welding Alloys Co., Inc.

CONSTRUCTION ON A NEW 30-story aluminum curtain-wall office building in downtown Manhattan is progressing smoothly now that a particular gremlin has been eliminated from the Mig welding machines.

The gremlin was an oxidization-caused whitish film on the welding wire which flaked and caused the feed rollers to clog.

The new building, being built for Uris Brothers by Michael Flynn Mfg. Co., Philadelphia, will be the world's largest aluminum curtain-wall structure. Approximately 350,000 sq ft of curtain-wall, 8,300 window units and 3,900 mullions will be used.

(Another Uris Brothers office building recently completed made use of 174,000 sq ft of curtain-wall. See *Aluminum curtain-wall "clothes" Manhattan building*, WELDING ENGINEER, June, 1958, p. 52.)

The window frames and mullions first are assembled, stacked horizontally on movable skids and firmly clamped for dimensional stability. The stacked units are then tack-welded with a Mig gun in sequence. Up to 10 one-inch welds per unit are made at the corners where frame sections meet and at mullion ends.

But before all this shop-welding was put on a smooth-running basis, equipment breakdown was occurring one to three and four times daily.

Arc contact, instead of being confined to the filler-wire tip, was travelling back up the wire and charring the feed tube. These "burn-back" breakdowns, lasting from 5 to 90 minutes, averaged 30 minutes.

Average cost of each breakdown was approximately $8, or a conservative estimate of $80 per week.

The weldors were experienced in Mig welding; the equipment was checked and re-checked; new equipment was brought in and tried—but the same trouble continued.

Analysis of the standard dull-etched welding wire showed no variation from normal, however, it still was not feeding properly.

When the flaking oxide film which was collecting on the feed rollers and preventing consistent feeding was discovered, a search of available aluminum wire was made.

A bright-finished, extruded and precision spooled wire was found. Extrusion provided accurate roundness and uniform density for consistent speed. But most important, the wire was clean and protected from oxidation by air-sealed wrappers.

When used in the Mig welding unit, the new wire, a 4043 type made by All-State Welding Alloys Co., Inc., worked properly without any burn backs. Although the welds in this case were not structural, the solution can apply to all other welding operations where high quality is required.

Time economics were also involved in the problem. The 70,000 welds made on the job required 29 days using the new wire. Using the old wire with its resulting breakdowns would have extended construction time to more than 33 days. The time saved was worth more than the price of the new aluminum wire, according to the Flynn Co.

NOW YOU CAN GRIND AND FINISH

NEW BAYFLEX DOUBLE-DUTY

Illustrations above show Bayflex Double-Duty in action, held at correct angle for weld bead grinding (top) and for finishing (botto

WITHOUT CHANGING WHEELS!

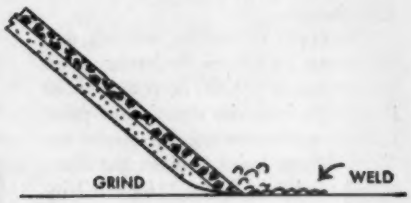
There are two important angles to consider before you buy new weld-grinding or finishing wheels. Bay State's new Bayflex Double-Duty raised hub disc-wheel has them *both!*

The "DD's" unique, two-layer construction gives you two grinding angles: One is 30° - 45° which gives you fast stock removal for grinding weld beads . . . and the other is 10° - 20° which gives you a finish without gouging, a finish so smooth it's just short of a polished surface.

The upper layer for weld grinding comes in a single, standard specification. The lower finishing or blending layer comes in your choice of five different grits (24, 36, 54, 80 and 120) for every type of finishing job from heavy steels through light stainless sheets to aluminum and copper.

Your Bay State representative is ready now to demonstrate the Bayflex Double-Duty in your plant under normal working conditions. Get in touch with him and see what he can do to cut costs and speed up your weld grinding. You'll find he's more than a good salesman . . . because he's an experienced abrasive specialist, too. *Better grinding at lower cost . . . that is his business.*

S 2 WHEELS IN 1



Upper layer removes stock rapidly when disc is held at 30° - 45° angle.

Lower layer smooths and blends surface when held at 10° - 20° angle.

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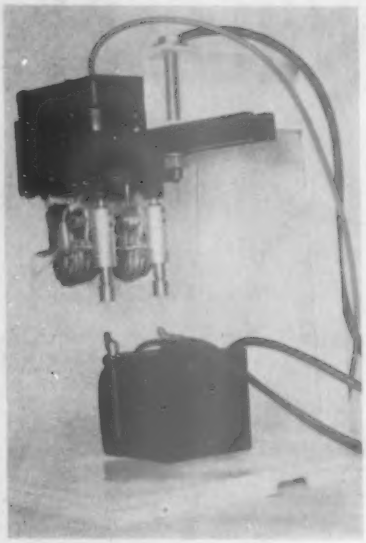


FIG. 1—On the Cooper welding unit, these two transformers have an 8.8 kva rating though the bottom transformer is only a 4-in. cube.

Compact . . .

Powerful . . .

Flexible mounting . . .

High production rate . . .

A new unit solves multiple spot welding problems

MULTIPLE SPOT WELDING of thin gage sheet metal has always presented a problem, often an insurmountable one, for manufacturers.

Cooper Welders, Inc., Morton Grove, Ill., however, now claim to have a solution—one which will provide perfect spot welds, perfect to the point of being invisible on outer surfaces of such items as metal cabinets, furniture and boxes.

These claims center around a newly developed system for multiple spot welding. Heart of the system, called a "Push-Pull" welding assembly, is a series-opposed split transformer. The assembly consists of a dual-point moving-electrode welding unit and a dual-point backup unit. (See figure 1.)

The two transformers have an 8.8 kva, RWMA Class F rating, yet the backup unit is contained in a 4-in. cube. According to the company, so much welding capacity has never been contained in such a small unit. Secret of this compactness is water cooling and an intimate thermal relationship between secondary and primary windings.

The backup unit of this dual push-pull assembly is in reality a stationary electrode unit. Usually it is mounted independently with other units on the matrix portion of a die-set or fixture (moving platen, shuttle or roll-in carriage type).

Offset electrodes can be raised or lowered as much as $\frac{5}{8}$ in., and can swivel in the clamp-type water-cooled holders. Mounting flexibility is obtained through tapped mounting holes provided on four surfaces of the transformer.

The upper or moving welding unit is the same width as the backup unit, but measures $5\frac{1}{2}$-in. deep and about 8-in. high from the shunt's low point to the transformer top. Electrodes are No. 1 Morse taper, and on the illustrated model, in figure 1, have a 1-in. stroke.

Considerable mounting flexibility is also provided for the moving unit, *i.e.*, above or below its supporting member by an adjustable fork. The moving transformer's position can also be reversed to meet work requirements.

Using an adjustable fork mount, only a $\frac{1}{2}$-in. diameter bolt is needed to secure the unit in place. In addition, the fork mount is supplemented by tapped holes on four sides to provide flush surface mounting on the front, top or either side.

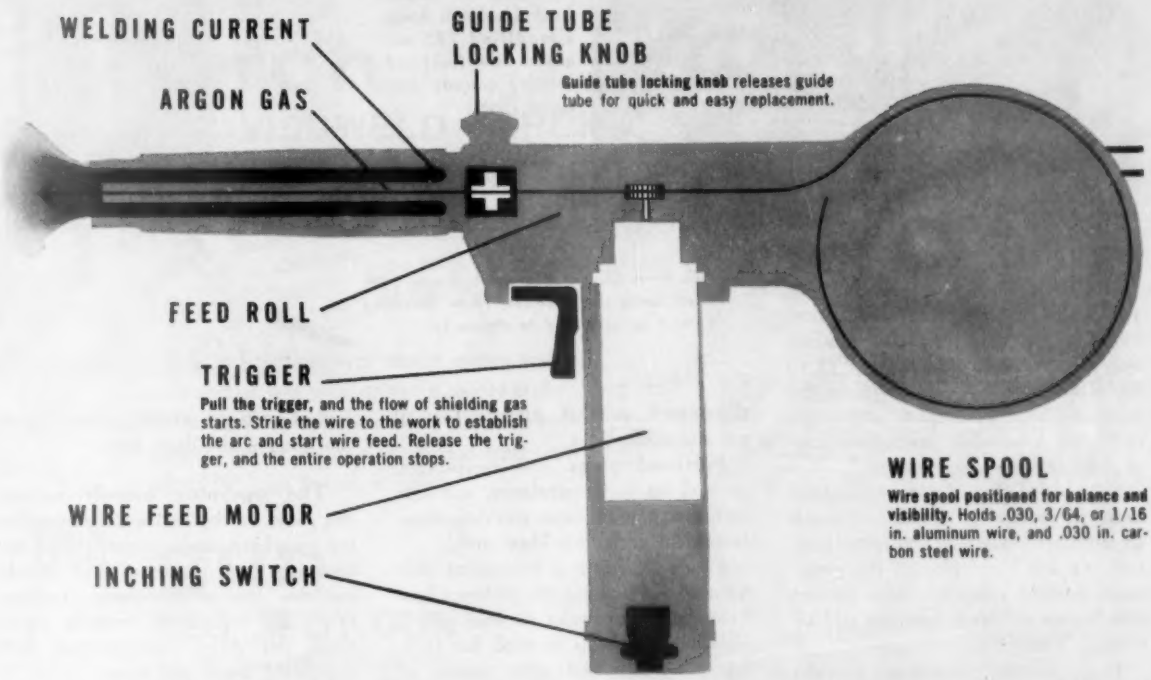
An example of how the Cooper welding unit may be used in a fixture setup is shown in figure 2. This production welding fixture is designed for automatically jigging and joining two 18-gage rail slides to the drawer pan of a kitchen cabinet.

The machine can be described as a four-head, eight-point welder. Each welding head assembly is mounted for floating, self-centering of the work parts.

Welding units are cocked slightly along the center line to place the spot weld rows on separate axes. The two left hand units are spring loaded to return to stops, which permits quick loading and unloading of

FIG. 2—Four Push-Pull assemblies are mounted on this drawer welder. It is easily adjusted for welding drawers 11 to 32 in. wide.

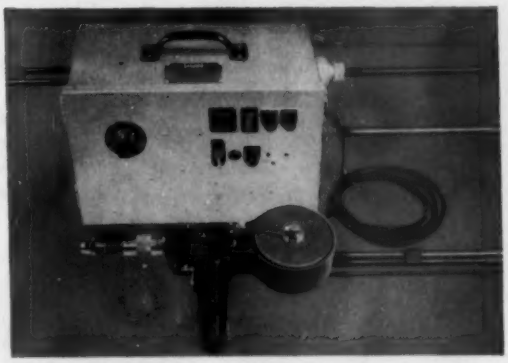
Try LINDE'S New "SIGMETTE" Torch!
—PORTABLE, COMPACT


WELDING CURRENT
ARGON GAS
GUIDE TUBE LOCKING KNOB
Guide tube locking knob releases guide tube for quick and easy replacement.
FEED ROLL
TRIGGER
Pull the trigger, and the flow of shielding gas starts. Strike the wire to the work to establish the arc and start wire feed. Release the trigger, and the entire operation stops.
WIRE FEED MOTOR
INCHING SWITCH
WIRE SPOOL
Wire spool positioned for balance and visibility. Holds .030, 3/64, or 1/16 in. aluminum wire, and .030 in. carbon steel wire.

Here's the torch that goes to the job—lets you work in any position . . . in confined spaces . . . at distance remote from the power source!

Designed for Sigma welding of light metals, the "Sigmette" torch is compact and sturdy. Notice the thin silhouette and position of the spool for complete visibility. Torch and control are completely insulated and grounded—the operator is protected from electrically "hot" parts. And the only maintenance tool needed is a screwdriver!

Find out how Linde's new "Sigmette" torch can speed your operations, bring new economies through its advanced design features. For a free demonstration and detailed information, mail the coupon today or call the nearest Linde Office.



Complete unit—torch weighs 3 pounds, 1 oz.; control weighs 19 pounds, 2 oz.; Current rating, 125 to 200 amp.; Welding power, direct current reverse polarity

Dept. WE-4, Linde Company
Division of Union Carbide Corporation
30 East 42nd Street, New York 17, N. Y.

☐ Please send complete facts on the new "Sigmette" torch.
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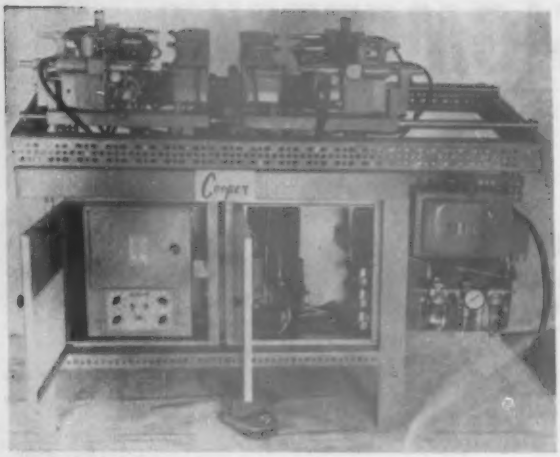


← FIG. 3—Ease of adjustment and compactness are top features of this four-head, eight-point spot welder. Control cabinets house a modified 3BX sequence timer (left) and auxiliary cascade contactor (right).

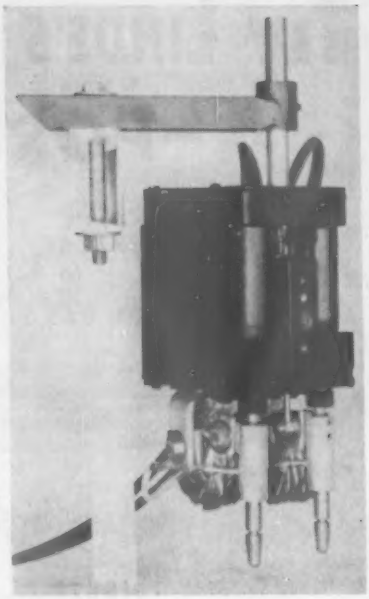


FIG. 4—A Cooper dual-point, single-sided series spot welder. Note mounting method as compared to Figure 1. →

parts. (See figure 3.)

The fixture's top frame, built of perforated construction steel, provides instant adjustment for welding any drawer pan ranging from 11 to 32-in. wide. A foot contact places the machine into a complete automatic cycle for a possible production rate of 250 drawers per hour.

Sequence firing of fixture-mounted units in groups is possible through an auxiliary cascade contactor control (on the right side of the right-hand control cabinet). The cabinet also houses a Size A Ignitron and an 80-amp contactor.

The cascade contactor permits four rapid-sequence firings so welding may be done on a 30-amp fused power source. (In this case, the control is used in conjunction with a 3BX timer modified to meet the unit's special transformer requirements.)

According to the manufacturer, the cascade units can handle up to 10 welding sequences if desired.

Another Cooper development is an auxiliary dual-point single-sided series spot-welding unit suitable for series welding where low-finished welds and long center distances are not objectionable.

The unit, also using a water-cooled transformer, is essentially the same as the Push-Pull welder. The only difference is a 2½-in. greater height and, in the model shown in figure 4, a 2-in. stroke actuator.

Mounting flexibility is again obtained through single-bolt adjustable fork mounts, and the one-hole front, top and end flush-mounting arrangements. Another feature included in both units is the midget quick-disconnect shut-off fittings for all air and water lines.

Polarized plugs and receptacles, as well as water strainers, are also included to guarantee working satisfaction of each individual unit.

Figure 5 shows a dual-point unit fixtured for making two indirect spot welds at right angles to each other. This special setup is used for joining the inner and outer panels of kitchen cabinet doors and drawer fronts.

Each of two Cooper series welding heads carries one electrode assembly. (A secondary return circuit is connected to each head in common to a down-acting shoe contacting the inner panel.) Thus, two spot welds are made with no electrodes in the hollow sections, avoiding marring or marking of the door face.

The operator merely rotates the panel on the hardwood slat tabletop, pushing each corner into the squaring stop, where a limit switch initiates the all-automatic welding cycle. The equipment, making eight welds per door, can produce 250 completed doors per hour.

This high production rate is possible because of electronic controls. A modified N2X welding control provides the sequence.

One additional feature of the unit is its small floor-space requirements, 4 sq ft. The entire unit can also be mounted on roll-away casters for easy removal from the work area when not in use.

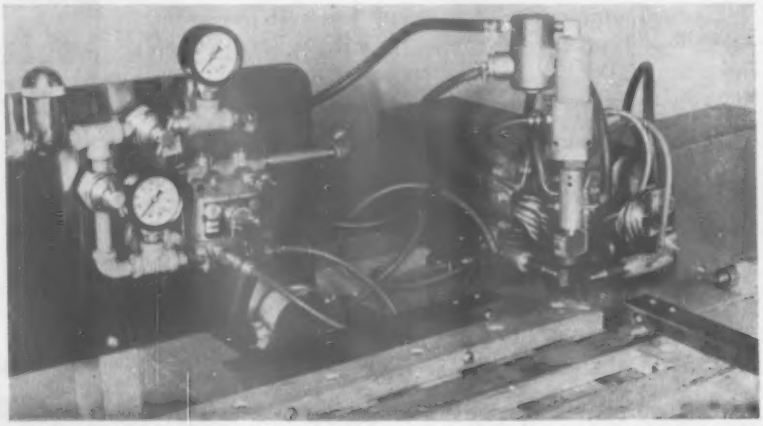


FIG. 5—Two dual-point, single-sided series spot welding units are used on this door corner welder. They make 2,000 welds per hour to produce 250 finished doors.

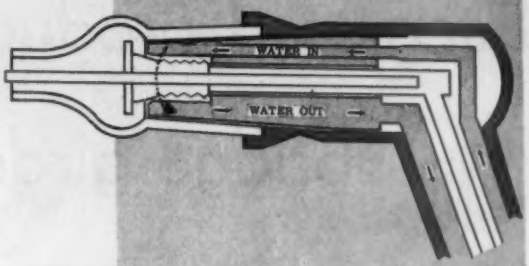
the TOP TIG welding TRIO

the torch

TEC VISUWELD TORCH

The proven tungsten inert gas welding torch contains all these exclusive features: the lightest weight . . . only 3 ounces . . . maintenance free . . . no parts to wear or leak . . . 3 to 350 amps. . . . topped with a Visuweld transparent gas nozzle which presents a clear, unobstructed view of the weld area at all times.

Unparalleled tip-of-the-torch cooling system continuously releases cool water where it's needed most . . . at the tip-of-the-torch. Guaranteed gas and water leakproof due to one piece torch head construction without "O" rings, threads, or gaskets.



the gun

TEC SPOT GUN

This TIG spot welding tool perfectly bridges the gap between resistance welding and TIG arc welding. The TEC Spot Gun has been designed to increase production output and replace expensive spot welding operations. The lightest weight, most compact spot gun ever made, it comfortably fits the operator's hand. Weld up to, and including ⅛" thickness to any size stock and in any joint design. There are no movable parts to wear or replace, permitting maintenance free operation. Touch starting is replaced by high frequency arc starting, reducing electrode waste and work contamination.

the control

TEC SPOT CONTROL

This perfect welding mate for the TEC Spot Gun, converts any DC power source into a new TIG spot welding machine. A choice of preset welding times can be selected at the gun itself. The TEC spot control unit is light and compact, with easy to read controls. It is the only control unit of its kind. This portable TEC spot control unit can easily be connected to any DC power source.

all from —TEC

Write for full information

TEC TORCH COMPANY, INC.

300 PATERSON AVE., CARLSTADT, N. J.

TWO automatic submerged arc welding heads work simultaneously on each side of girder, making fillets in one pass. Welding speed is 25 ipm. Pedestal-boom manipulators controlling heads run on common track.

Integrated production speeds bridge girder assembly

ALL-WELDED PLATE BRIDGE GIRDERS will be used for the first time in Ohio history when R. C. Mahon Co., Detroit, erects five overpasses on the state's Conneaut to Cincinnati turnpike.

Mahon has developed its own production system to help speed bridge erection and keep shop costs down. The system utilizes overhead cranes, two special universal fixtures, and semiautomatic and automatic submerged-arc welding. The system requires only 14 separate operational stations—from pre-welding cleaning to painting of completed girders.

The production sequence begins with semiautomatic submerged-arc welding of flange and web plates. A universal splicing fixture is used which can handle plates up to 18 in. wide and 120 ft long.

Flange plates range in size from 9/16 in. to 2 in. thick, and from 12 to 18 in. wide. Web plates range from 3 ft 10 in. to 4 ft 10 in. deep.

Huge overhead cranes are used to position web and flange plates on the fixture. The flange plates are aligned and held in place with C-clamps and shims. Run-off bars are tack welded to the ends of the joints.

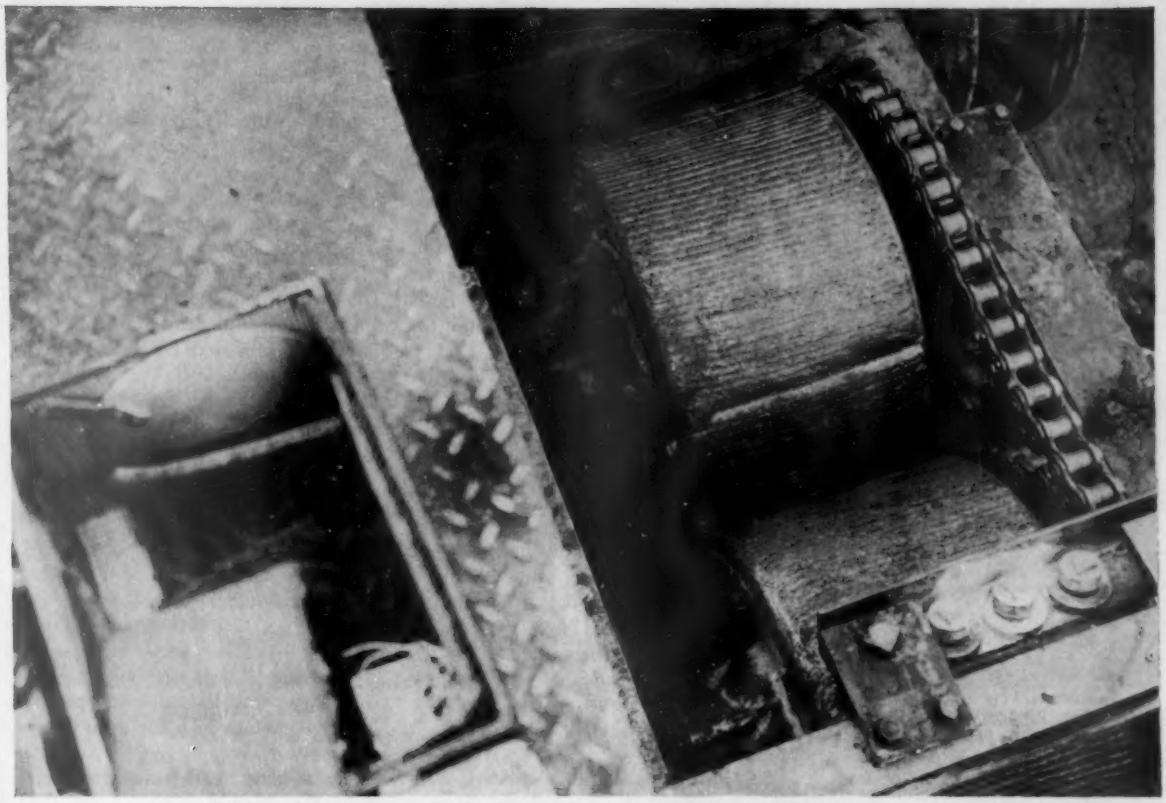
WELDOR joins stiffeners to web plate of girder assembly with fillet welds in one pass. When all stiffeners are welded on one side, huge crane turns girder over so supports can be added to other side. Prior to welding, fitter positions stiffeners and tacks them in place.

A weldor and fitter work as a team. While the weldor joins flange sections, the fitter positions and tack welds web sections. A copper backup bar is placed under the joints.

When the weldor has completed the multiple flange passes, he moves to the web plates where joints are made in one pass. Meanwhile, the fitter returns to the flange plates to grind the finished welds.

A crane then turns the units over. The weldor back-gouges the first flange seams and welds the backup side of all joints. The fitter works with the weldor at the flange joints, removing all clamps and flame-cutting run-off bars.

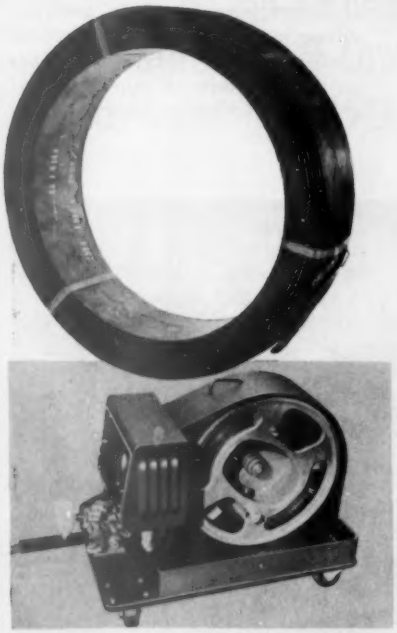
Run-off tabs are of the same metal



CRUSHER EQUIPMENT FOR SUPER HIGHWAYS

maintained easier with

STOODY SEMI-AUTOMATIC HARD-FACING



Stoody Semi-Automatic wires are available in a variety of alloy types for all job requirements. They can be fed through most standard semi-automatic welding machines.

Near Grants, New Mexico, a new super highway is under construction. Keeping crushers in operation to supply aggregate is a tough job. Roy Hartman, the welder, states, "I like to hard-face with the Semi-Automatic machine. On crusher rolls, I can lay down from 7½ to 10 pounds of Stoody 100 per hour but only about half that much when applying manual electrodes—even though working hard. Semi-Automatic hard-facing makes my job easier."

To lick the toughest jobs fast, with less wear-and-tear on yourself, just try Stoody Semi-Automatic Hard-Facing. A variety of alloy types cover all hard-facing requirements. If you'd like a demonstration in your own plant on your work, simply ask your nearest Stoody Dealer (see the "Yellow Pages" of your phone book) or write direct to the company.

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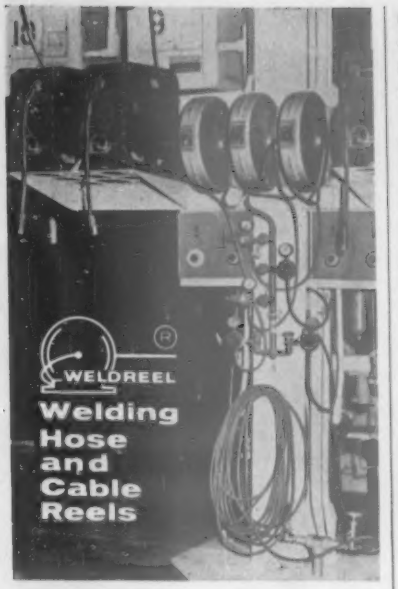


AT PHILLIPS PETROLEUM

Plant safety is improved —hose and cable life extended —good housekeeping is made simpler—in Phillips Petroleum Corporation's refinery at Borger, Texas, by keeping hose and cable off the floor when not in use—with WELDREEL hose and cable reels.

WELDREEL reels pay out freely and lock automatically at desired length. A slight tug releases the locking pawl, allowing hose or cable to be automatically retracted.

Designed to handle flammable fluids and gases safely in dual and single hose, leakproof WELDREEL reels are adaptable to a wide variety of industrial applications. Write for full information.

MODEL OA-A holds 50′ of 3/16″ or 40′ of ¼″ dual hose. Model OAB has capacity for 150′ of ¼″ or 125′ of 5/16″ hose.

MODEL EA-2 with current capacity of 300 amps holds 50′ of 2/0 welding cable. Model EA has capacity of 100′ cable.

MODEL A-1 has 50′ capacity of ¼″ or 3/8″ I.D. single hose. The larger Model A-2 holds 50′ of ½″ hose.

UNITED SPECIALTIES INC.
POST OFFICE BOX 608 ····· EL DORADO, ARKANSAS

as the flange and webs. When burned off, they serve as a quality-control measure to check the welds on the main section.

The weldor completes his operation by going back to the web plates to weld the backup side of their joints.

Typical web plates are joined at 500 amp, 35 volts. Sections are fitted from 0 to 1/32-in. gap. Welding is done at a rate of 20 ipm, providing a ¼-in. penetration.

A 100-ft universal assembly fixture is used to make complete girders once web and flanges are completed. The fixture, which can be adapted to any length steel member, has vertical uprights and adjustable jacks which center the horizontally fixed web plates on two vertically fixed flanges.

A crane swings the web plate on to the fixture and follows up with flanges. The web and flanges are tack-welded in position, and the entire assembly is transferred to support beams for final welding.

Continuous fillet welds are used to permanently join girder assemblies. Two automatic submerged arc welding heads are attached to boom-pedestal units running on a common track. Current supplied to both heads is 500 amp, 30 volts. Welding is done at a speed of 25 ipm. One pass is made on each joint using 5/16-in. mild-steel filler wire.

An accompanying photo shows the two heads, in staggered position, working on opposite seams.

When the fillets have been completed, the girder assembly is turned over by a crane and the other flange-to-web welds are made, following the same procedures.

Next, stiffeners are welded to both sides of the girder. After tacking, a semiautomatic gun is used to lay fillet welds along the web and base of each stiffener.

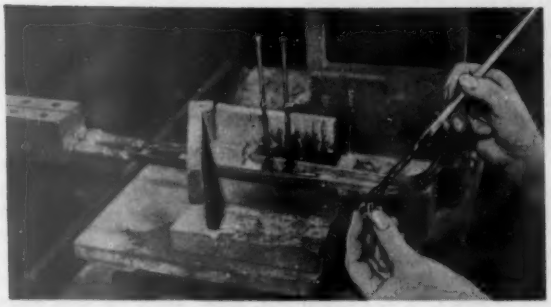
Completed girders are then trimmed and prepared for field erection and painting.

As many welds as possible are made in unrestrained condition to minimize and balance residual stresses. Welding is done in long runs wherever it can be arranged.

The costs of such large weldments are already 85% that of other joining methods. The production system devised by Mahon knocks this down a few more percentage points. Use of special fixtures along with the sequence provides an estimated 25 to 30% savings in labor delays, says Mahon.

By welding, and using its special job plan, Mahon gains several field erection advantages, too. Accurate pre-assembly in the shop is obtained, and members of equal strength but of lighter weights can be used, resulting in savings on main structural steel members. Additional savings are realized through elimination of accessories needed in other means of construction.

TWO flange plates being spliced in universal roll-over fixture. Weldor will complete weld in 10 minutes. Run-off tabs shown will be flame-cut when weld is completed, and serve as quality-control measure to check welds on main section.



Operator applying Special Handy Flux Type B-1 to components of de-icer tube before brazing.

Here, four de-icer assemblies in jig are being brazed by induction heat.

First step in brazing manifold. Operator applies Special Handy Flux Type B-1 to joint area prior to hand brazing. B-1 Flux is particularly effective in removing refractory oxides such as those formed in stainless steels and carbides.

Operator preheats joint area before hand feeding Handy & Harman silver alloy Braze 541.

Here's how you can get uncompromising JOINT STRENGTH at LOW-COST... Handy & Harman SILVER BRAZING

Here, two different parts are being brazed. Operator in foreground hand feeds alloy on aircraft manifold joint while operator in background brazes nipple on hydraulic oil filter. Gas-air hand torches are used in both cases.

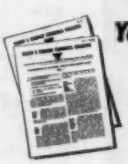
The first requisite for virtually any aircraft part is unimpaired strength. Jerden Manufacturing Company, Indianapolis, makes a number of tubular aircraft parts and components and each of them must pass rigid tests before acceptance. Three of the components are a hydraulic aircraft filter, a manifold assembly and a de-icing tube. Tubes and fittings are 410 and 321 stainless steel, brazed with Handy & Harman silver alloy Braze 541 (formerly 4772).

Handy & Harman's Braze 541 is specifically formulated for brazing stainless steels. It has a high flow point (1575°F), and its excellent strength at elevated operating temperatures especially recommends it for many aircraft component applications. Braze 541 is a "tailor-made" brazing alloy, designed to do a specific joining job and do it particularly well. It is an example of Handy & Harman's ability to supply a specific alloy to fit a specific need, a service that remains constantly available to you.

You may find that your metal joining requirements are more or less special or you may not be fully aware of what you require. In any case, we invite you to consult us about what you are joining and *would like to join better*. We may be able to help you from many points of view: economy, joint strength, conductivity, ease of production and many others.

GET THE FACTS

Technical Bulletins T-1 and T-2 give the general characteristics of silver brazing alloys plus the compositions, melt and flow points of 36 separate alloys. Write for your copies.



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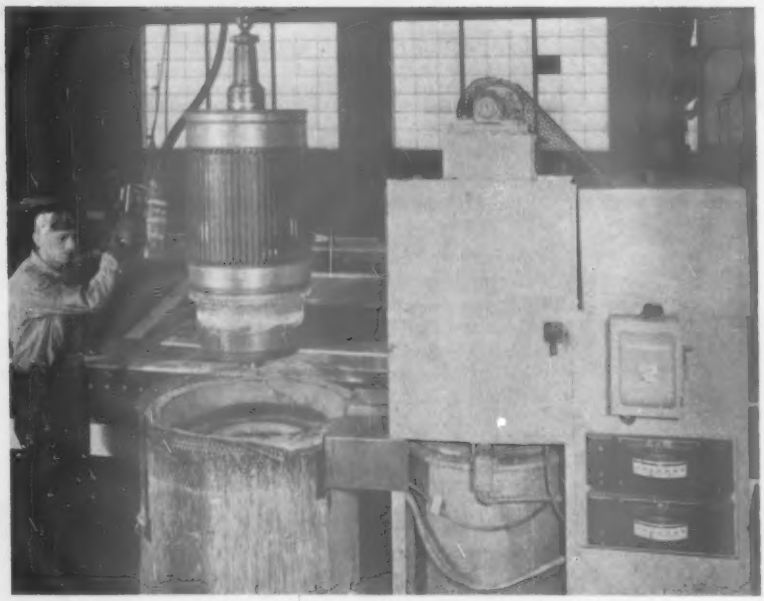
BIRD'S-EYE view of welder working on liquid oxygen container at Ronan & Kunzl plant in Marshall, Mich. Outer aluminum shell is being fabricated from 52S aluminum sections 1/8 to 1/4 in. thick, using 3/64-in. 52S welding wire and argon shield. Welder is using Air Reduction Co.'s Aircomatic Pull Gun and supporting system. By switching from manual to semiautomatic Mig process, Ronan & Kunzl is obtaining a welding production speed seven times faster than that obtained with old method.

MIG spot welds, shown on circumference of section below, were used to join pleats for bellows-type expansion joints used in fume-stack ducts. Special joints are needed because ducts are subjected to quick temperature changes which cause extreme expansion and contraction. Twenty-eight pleats, made of low-carbon steel, are needed to make complete assembly. Each pleat requires 200 spot welds, made with 1/16 in. diameter wire. Below, weldor Tig welds pleats to form bellows-joint. Work is done at Hulbert Bros., Salt Lake City, U., using Linde Co. equipment.

On the job...



TRACTION motor armature being lowered into soldering pot. Pot is part of new system, developed by General Electric Co., that has slashed soldering time of armature coils to commutator bars 50%. More than 50 connections can be joined in one operation within 10 to 15 minutes. Equipment used consists of base holding soldering ring, solder reservoir, cylindrical displacement weight, electric immersion-heaters, and controls for weight and heaters. Prior to soldering, armature is heated to 300 F. Whiting is applied to commutator to prevent solder from adhering. Three immersion-heaters, rated 1,500 watts each, melt pure tin solder which is shot through trough to four 1,000-watt cast-in immersion-heaters in soldering ring. Then, commutator end of armature is lowered into ring and automatically joined.

MESSAGE #6 *This message is for men who are vitally concerned with such welding problems as maintaining a smooth flow of production... preventing excessive rejects... and insuring trouble-free, economical, profitable operation*

Welding Wire: Cost-saving and Profit Factors

Production men who are conscious of *both cost and quality* agree that a top-grade weld demands the *right* welding wire. *Only* by using wire with an analysis suited to the material to be welded can consistently sound welds—free from porosity and internal cracks—be produced. Use of the right wire means fewer rejects, less waste, lower costs—plus a better finished part or product.

Experienced welding men have long found PAGE a most reliable source of welding wire for all their regular and special needs. The wide range of PAGE analyses—33 of them—makes it possible to select the exact wire that produces the kind of welds that lower production costs and increase profits.

PAGE experience, talents and facilities are available to you at all times. We have been exclusive wiremaking specialists for more than half a century, and are in an ideal position to furnish our customers with the right wire for each specific need. Furthermore, we have developed a broad packaging program which saves time and money by supplying wire packaged to meet any requirement.

These factors, plus PAGE'S nationwide set-up of conveniently-located distributors, backed up by PAGE warehouse stocks, help make it profitable for you to standardize on PAGE Welding Wire.

PAGE offers—
33 ANALYSES
...the right analysis for your welding job

There are *33 different analyses* in the PAGE line, covering the broadest range of applications: submerged arc...inert gas...tungsten or metal arc...oxy-acetylene gas welding...metal spraying.

For example—ANALYSIS A-S-18

The new Analysis A-S-18 welding wire was specially developed for CO_2 welding of .25 to .50 carbon steel—also for welding of free-machining, sulphur-bearing steels of the AISI-1100 series. These grades of steel have never before been satisfactorily welded by inert gas or submerged arc methods. They can be welded now as easily as low carbon steels.

As evidence of its superiority, note these physicals attained with A-S-18 on .35 carbon steel joints using CO_2 inert gas:

Tensile Strength—75/81,000 p.s.i.
Yield Strength—55/61,000 p.s.i.
Elongation—24%

Equal results are obtainable using a submerged arc procedure with a neutral flux. And, even higher tensiles can be expected on higher carbon steels!

The other outstanding use for A-S-18 welding wire is in welding free-machining or sulphur-bearing steels of the AISI-1100 series. Previously, this has been a difficult, in fact, an almost impossible job. With A-S-18 the sulphur is "boiled out" by the deoxidizers in the wire; the result is a non-porous, high quality weld.

Welding men who are anxious to increase the quality of their work with these difficult grades of steel will want to test this remarkable A-S-18 welding wire under their own working conditions. They will be happily surprised at the results!

For example—ANALYSIS A-S-25

Formerly known as A-S-20-G, Analysis A-S-25 is a modification of A-S-20 where the deoxidizing agents are increased to provide scavenging of all metallic oxides and other impurities, giving (with CO_2) particularly good welds in low-carbon (AISI-1006 to 1022) steel plates. Owing to the higher alloy content, it costs a little more than A-S-20, but for inert gas welding it is well worth it, as it eliminates porosity and underbead cracking.

Analysis A-S-25 is recommended for all miscellaneous CO_2 welding on mill steel work. It will give a tensile strength of approximately 75,000 p.s.i. with an elongation of 26%.

NOTE: previous advertisements in this publication have included brief descriptions of PAGE Analyses A-S-8620, A-S-6150, A-S-30, A-S-NAX-9115, A-S-65, A-S-Armco Iron, A-S-6, A-S-17, A-S-10, A-S-15 and A-S-16. Detailed information on all 33 PAGE analyses is contained in our Welding Comparison Chart DH-1218.

***Write for*—Welding Wire Comparison Chart DH-1218....** This new, highly informative, four-page chart lists detailed analyses of PAGE automatic welding wires, metal spray wires, bare electrodes and gas welding rods. Also shows uses and physical properties, including: tensile strength, elongation, Rockwell hardness. Chart lists virtually all competitive makes.

***Write for*—Submerged arc and inert gas welding wire Folder DH-402A...also gas welding rod Booklet DH-1277.**

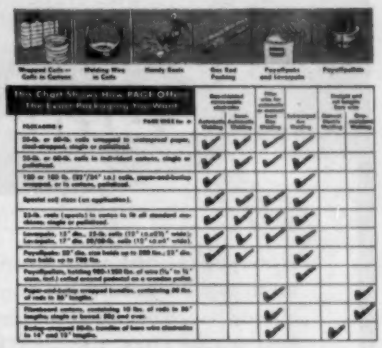
PAGE offers—
Packaging to meet your needs

PAGE Welding Wires are packaged in a wide variety of ways—for the most complete protection and the utmost convenience in handling, in stocking and in use. Here are some major types of PAGE packaging:

1. **Paper-wrapped Coils**
2. **Coils in Cartons, Palletized**
3. **Bare Coils (packed in Leverpaks)**
4. **Masonite Reels**
5. **Payoffpaks**
6. **Payoffpallets**
7. **Gas Rods in Burlap-wrapped Bundles**
8. **Stainless Gas Rods in 10-lb. Tubes**

For example—

PAYOFFPAKS...Up to 700 lbs. of wire, without a single weld...coiled around a fiberboard cylinder within a fiberboard drum...ready to be smoothly unreeled to the welding head for automatic or semi-automatic welding! Eliminates costly machine down-time for coil replacement. Payoffpaks come in three sizes: 20" diameter (holds 250 or 500 lbs.); 23" diameter (holds up to 700 lbs.).



***Write for*—PAGE Welding Wire Packaging Chart.** • This useful chart shows the many kinds of packaging of PAGE Welding Wires for each type of welding.

PAGE offers—
Availability from local stocks

Here is a handy service that not only gets you the welding wire you need when you need it, but saves you money by making it unnecessary for you to tie up a sizeable investment in wire inventory.

You can get the exact PAGE automatic welding wire and welding rods your job requires direct from your nearby PAGE Distributor. Located at many points from coast to coast, PAGE distributors carry sizeable stocks for your convenience—and they are backed up by PAGE Warehouses at the strategic locations shown below. Close cooperation between PAGE distributors, PAGE warehouses and the PAGE mill is your guarantee of prompt, intelligent, individual service on your specific needs.

ACCO

Page Steel and Wire Division
AMERICAN CHAIN & CABLE

Monessen, Pa.*, Atlanta, Chicago*, Denver*, Detroit, Houston*
Los Angeles*, New York, Philadelphia*, Portland, Ore.
San Francisco*, Bridgeport, Conn.
*Indicates PAGE warehouse stocks

ACCO for Better Values

New Hi-Impact Plastic Insulated

Panel Receptacles and Mating Plugs

Now, you can make fast, positive power connections to any metal panel or housing without special insulating materials. Simply punch out a hole and insert a Cam-Lok self-insulated Receptacle! Uses standard electrical lock-nuts, affords "dead-front" protection. Push in and twist Cam-Lok mating Plug and you've made a locked connection, which can be released quickly.

New Cam-Lok Receptacles eliminate costs of special insulating panels and reduce assembly time. Patented, high-pressure contact assures minimum resistance and heating.

Cam-Lok has a complete line of Receptacles and Plugs in many sizes and designs. Standard and special purpose Power Distribution Connections are available. Write today for new Bulletin No. 301.

"Dead Front" design for fast direct mounting on . . .

• ELECTRICAL DISTRIBUTION PANELS • SWITCHGEAR
• BUS DUCT • JUNCTION BOXES
• WIREWAY or any electrical cubicle

See the Cam-Lok line, Booth #217, AWS Welding Show, Chicago International Amphitheater, April 7-10

cam-lok DIVISION

EMPIRE PRODUCTS, INC.
P.O. BOX U-98
CINCINNATI 36, OHIO

On the Great Lakes—

Canadian firm turns to welding for economical ship repairs

BY REPLACING riveting with submerged-arc welding, Port Arthur Shipbuilding Co. of Ontario, Canada, sharply cut the cost of repairing tank tops on two Great Lakes freighters.

The ships, *Gleneagles* (15,000 tons) and *Ashcraft* (12,500 tons), have been completely refitted with new tank top plates, using the speedy submerged-arc process for both seam and plug welding.

Mild-steel plates, 30 ft long, 7 ft wide, and 7/8 in. thick, were beveled 22½ deg on all edges, making a 45-deg included angle when butted. After being positioned and manually tack-welded to supporting angles in the ships' holds, the plates were seam welded around the edges and plug welded in three equally-spaced courses. Linde Co. equipment was used.

Seam welds were made at 12 ipm and required three passes. To provide proper back-up for the automatic welding, manual welds were made to fill the gaps between intersecting supporting angles.

For plug welds, the machine was positioned over the hole and welding flux was heaped around the weld wire, filling the hole. After the machine was started, a measured length of wire was fed into the weld puddle. Each plug took 17 seconds to complete.

Four submerged-arc machines used 15,000 lb. of welding wire for the jobs, a great deal less new metal than riveting would require. When riveting, 100% new metal must be supplied and plates must be overlapped. Submerged-arc welds needed only 30% new metal; the balance, of course, is base metal melted to form the weld. Overlapping is eliminated when weld-

ELECTRODE is placed into hole along with steel wool used to complete circuit at start of plug welding.

OPERATOR fills hole with weld composition. Measured wire is fed into hole after machine is started. Plug weld takes 17 seconds.

SERIES of plug welds and longitudinal and transverse seams. Welds join new plates to angle supports.

ing, further minimizing waste metal.

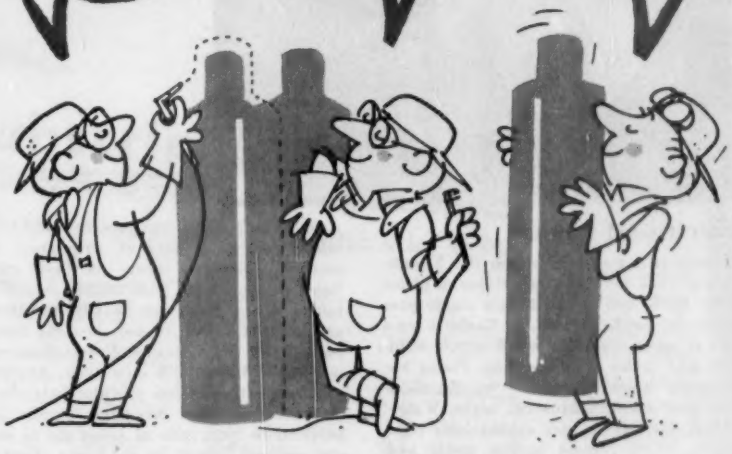
Welding proved economical for other reasons, too. It eliminated the cost and time of punching holes in supporting angles, and saved an operator the difficult job of moving in a confined area to head rivets.

PROVEN FIELD RESULTS!

HOLDS 15% MORE GAS!

WILL NOT SPIT ACETONE!

IS OVER 7% LIGHTER!



They're talking about...

NORRIS-THERMADOR

Acetylene Cylinders

You'll talk about them too, when you see for yourself how Norris-Thermador's high-strength shell and high-porosity filler give a greater return on your cylinder investment.

SEVEN LEAGUES AHEAD IN THE SCIENCE OF ACETYLENE CYLINDERS

Write or wire for the new specifications on all sizes from 10 to 350 cubic feet capacity. Cable: NORTHERM

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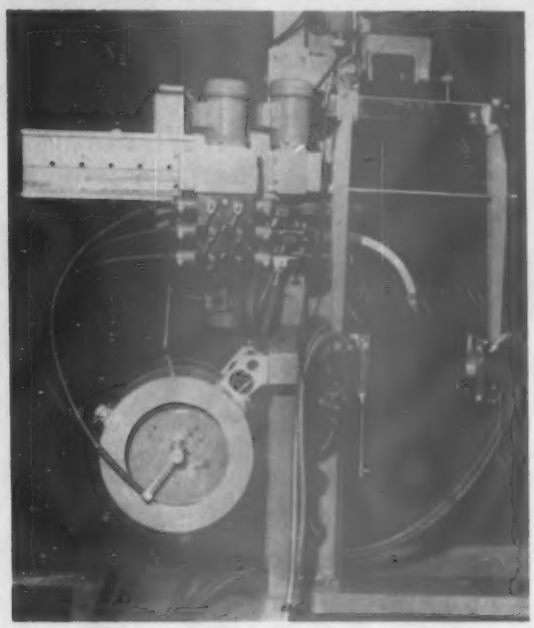
new products . . . use card on page 135

You can see many of these new products on exhibit at the American Welding Society's Welding Show to be held in Chicago's International Amphitheatre, April 7 to 9.



EUROPEAN made Electroslag welding machine, Vertomatic, permits butt welding of plates 1-in. thick, and thicker, in a single pass while in a vertical position.

Electroslag welder

VERTOMATIC, designed to use the Electroslag process, permits butt welding of plates 1 in. thick, and upwards, in a single pass while in vertical position. Machine uses one or more electrodes which supply welding heat under a molten slag. Plates are vertically mounted, spaced so electrodes can enter between flame-cut edges. Water-cooled shoes are placed against both plate edges, which contain molten metal and slag, and provide temperature sensing probes which actuate automatic travel welding process. Process permits deposition rates of 0.055 to 0.065 lb per amp per hour. On 2-in. thickness, complete weld is made in one pass at rate of 4 to 6 ft per hour. Process is suitable for welding heavy thickness of alloy steel. *Amalgamated Industrial Corp.*

Circle No. 1

Temperature indicators

TEMPILSTIKS, Tempilaq and Tempil Pellets for 331 F and 344 F have been added to fill gaps in company's line of temperature indicators. In addition to general heat treating applications, ratings can be used in spotting defective steam traps, in monitoring temperatures of electronic tubes and in postforming plastic surfacing like Formica, Textolite, etc. *Tempil Corp.*

Circle No. 2

Skelp welder

SCIAKY BPW .3—400H machine is for flash-butt welding hot-rolled, low-carbon steel ranging from 0.060 to 0.200 in. thick, and from 12 to 22 in. wide. Unit can also weld 4.5 sq. in. cross sectional area of mild steel, and 2.6 sq in. cross sectional area of stainless steel. Skelp welder is used in various mill and process operations where continuous feed of strip stock is essential. Machine shears off flash particles so continuous flush surface is maintained. Upset force can be adjusted to a maximum of 90,000 lb, and clamping force to 125,000 lb. Air-cooled transformers, rated at 400 kva, 50% duty cycle, provide weld current. Machine provides heat current and post heat. Secondary current is provided to both ends of lower die to insure uniform heating in weld area. *Sciaky Bros. Inc.*

Circle No. 3

Brazing flux

WONDERFLUX 4 is for induction brazing and other short cycle brazing operations. Flux has low surface tension, begins to melt at 480 F and is water thin at 800 F, says manufacturer. Wonderflux is said to be non-corrosive, non-hygroscopic and does not effervesce when heated. It comes in 1 and 5-lb jars. *American Silver Co.*

Circle No. 4

Bevel cutting attachment

BEVELING attachment, SC290, enables torch operator to change angle without extinguishing flame. Attachment is calibrated in increments of 15 to 90 deg on each side of vertical to permit cuts at most angles. Absence of stops on swivel member permits reverse beveling. Flexible seal rings keep gases separated until they mix in tip, allow hand adjustment of head and prevent foreign matter from entering seat. Head can be swiveled through its entire arc without extinguishing preheat flame. For straight line cutting of metal up to ⅝-in. thick, tip can be angled forward to 30 deg. to increase speed. *Smith Welding Equipment Corp.*

Circle No. 5

Structural steel electrode

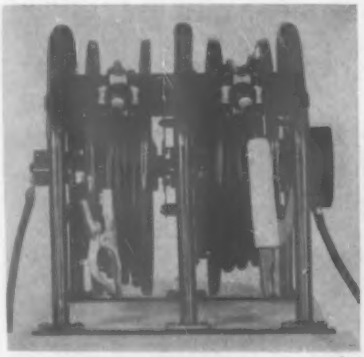
EUTECTRODE Super 110, a-c/d-c, combines high strength, 110,000 psi, with good elongation to completely eliminate cracking tendency, says manufacturer. Electrode is said to be valuable when joining heavy sections under restraint. No restrictions are placed on joint designs, size or position. Can be used on low alloyed steels, and steels with low percentages of nickel, chromium, molybdenum and manganese. Typical applications include structural steel, pressure vessels, and assemblies requiring extensive post heat treatment. *Eutectic Welding Alloys Corp.*

Circle No. 6

Cable repair kit

PORTABLE welding and power cable repair kit includes a circumferential crimping tool, cable cutter and insulation mounting tool. Hand operated kit uses no heat or power attachments, dies or molds. Cable sizes 4 through 500 MCM may be fabricated and repaired. Maximum electrical and mechanical efficiency is obtained from circumferential crimp, which eliminates high pressure points by evenly distributing pressure to all points on circumference. Insulators, made of Neoprene compound, are pressure fit into cable. *F. M. Anthony Co.*

Circle No. 7



Dual cable reel

WELDREEL dual cable reel, Model EA-10, is for both electrode and ground cables. Each reel has a capacity of 50 ft of 2/0 cable or shorter lengths of 3/0 or 4/0 cable. Current capacity is 300 amp with 60% overload factor for intermittent operation. Designed for both portable and fixed installations. Weldreel has retracting and locking pawl device. Though unit was designed for electrode and ground cable applications, it can be used whenever two heavy duty cables are needed. *United Specialties Inc.*

Circle No. 8

Low Temperature EUTECTIC WELDING ALLOYS

Plant, Research Laboratory and World Headquarters

HISTORY OF "EUTECTIC LOW TEMPERATURE WELDING ALLOYS"®

Surface alloying at low heat was first discovered by "Eutectic" in 1904 — used today in over 100,000 plants. "Eutectic" is the originator and sole manufacturer of "Eutectic Low Temperature Welding Alloys" for bonding metals at low heat, minimizing distortion, warping and stress.

EUTECTIC Welding News

PUBLISHED BY EUTECTIC WELDING ALLOYS CORPORATION, 40-40 172 STREET, FLUSHING 58, NEW YORK, N. Y.

RUNS 100,000 MILES...

ON LOW COST "EUTECTIC" OVERLAY

The bearings in this truck tractor's differential jammed, forcing rotation of the bearing races, galling the housing. A replacement was not only difficult to obtain, but represented a substantial investment.

The possibility of repair by overlaying was discussed, but no facilities were available for the complicated and excessive heat needed with conventional welding methods. It was particularly important, in overlaying the differential, to avoid warpage, distortion or embrittlement, and the finished deposit had to be machinable. A local "Eutectic" Technical Representative was called in. He recommended EutecRod 185 FC be used: a patented high wear resistant BronzoChrom alloy for the toughest bronze surfacing build-up. EutecRod 185 FC is particularly valuable on surfaces requiring constant resistance to frictional wear, and for general maintenance and joining. It has been used successfully in building up broken gear teeth, worn bearings, valve seats and pistons. Its low heat requirement even allows the joining of galvanized iron parts without damage to the zinc coating.

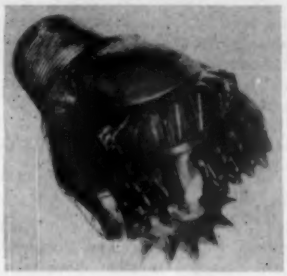
Fully machineable, EutecRod 185 FC supplants bronze welding and gives harder and tougher deposits having high ductility, a low coeffecient of friction and excellent corrosion resistance. Hardness is deposited, BHN 110; work hardness to BHN 200, and is deposited without fusion of the surface of the base metal.

The illustration shows the shaft successfully built up with 185 FC. This highly machineable overlay has such unusual toughness that it will outlast the bearing surfaces of a new shaft. The truck into which this shaft was replaced has since completed over 100,000 miles of rugged highway travel without any appreciable signs of wear.

The cost of welding and machining was only a very small fraction of the cost of a new shaft.

HARD ALLOY OVERLAYS PUT "BITE" IN ROCK BITS

The high cost of bits for oil drilling has made it necessary for all operators to investigate ways to extend tool life.



EutecBor 9, another "Eutectic" super high alloy overlay is growing increasingly popular for this purpose. It offers the utmost in heat, wear and corrosion resistance at normal and elevated temperatures, yet features an amazingly low application temperature; between 1800° and 1900°F. Mirror smooth, longer lasting deposits of RC 55-62 are obtainable without danger of penetration or undercutting.

EutecBor 9 permits repair and renewal of rock bits, core bits, hole bits, casing scrapers, reamers, reaming bits, fish-tail bits and similar tools and parts.

EutecRod 185 FC, available in 1/8", 3/16", & 1/4" dia. Extruded pink flux coating. • EutecBor 9, available in 3/16" dia. Lt Blue Tip. Standard weight shipments.

FREE WELDING ADVISORY SERVICE AVAILABLE THROUGH YOUR LOCAL "EUTECTIC" TECHNICAL REPRESENTATIVE

A staff of technical welding experts are ready to consult with you. Write for help on any welding problem.

Eutectic Welding Alloys Corporation
40-40 172nd Street, Flushing 58, N.Y.

Yes . . . Please have your local "Eutectic" Technical Representative call.

Name_____ Pos._____

Company_____

Address_____

City_____ State_____

EUTECTIC 'LOW TEMPERATURE WELDING ALLOYS' FORMULATED FOR 'LOW HEAT INPUT' BONDING OF ALL METALS INCREASE SAVINGS BY SALVAGE AND REPAIR, SOLVE PRODUCTION PROBLEMS

Brazing alloy

NICROBRAZ 160 is a new high-nickel brazing alloy for high-temperature service. It produces joints with low hardness that are easily machined. Hardness before brazing is 35 to 40 Rockwell C. Alloy has lowest boron content of Nicrobraz line. It has a wide melting range and is available as powder, impregnated plastic wire, powder-flux paste or prefabricated rings. It is recommended for furnace brazing in pure dry hydrogen or vacuum atmospheres. *Wall Colmonoy Corp.*

Circle No. 9

Electrode for nickel alloys

NITECTIC 222, d-c, is designed for use in operations where one joining member contains more than 50% nickel. Electrode can be used to make butt and fillet joints on nickel to Inconel, Monel, various grades of stainless steel, mild and low alloyed steels when fabricating or repairing evaporators, pressure chambers and turbojet parts. Weld is flat, machinable and crack-free, says manufacturer. Comes in 3/32, 1/8, 5/32 and 3/16-in. diameters. *Eutectic Welding Alloys Corp.*

Circle No. 10

Wiper dies

TUBE bending wiper dies and flexible mandrels are designed to meet close tolerance and extreme forming requirements on tubes of minimum wall thickness. Available in standard OD and wall thickness sizes, and in all bend ratios down to 1½:1. Smaller ratio dies and mandrels are available on special order. Adaptable to any standard brand of tube bending machine, says manufacturer. *Leonard Precision Products Co.*

Circle No. 11

Film badge

TWIN-Film Service is film badge to record radiation exposure with second sheet which adds 13-week exposure record to weekly record available through regular service. Other badges measure exposures above 20 milliroentgens. This means a person exposed to radiation must assume he has been exposed to this amount in a week, even if he has not. New Twin-Film Service reduces assumed minimum exposure in one year to 1/13 of a roentgen. *Tracerlab Inc.*

Circle No. 12

Bus plates

RESISTANCE welding control bus distribution plates in recognized dimensional and performance standards eliminates custom-fabricating of plates from plastic sheet stock. Blocks are molded of polyester plastic reinforced with glass fiber, and have high impact and dielectric strength and good corrosion resistance, says manufacturer. Plates are 1¼-in. thick, 6½-in. wide and carry 4½-in. bars for 400 and 800 amp service. Bus bar mounting holes, 7/16-in. wide, accept 3/8-in. head cap screws. *Synthetics Development Co.*

Circle No. 13

1,000 amp welder

NEW SR-1000-A1 welder delivers 1,000 amp d-c at 40 volts on 100% duty cycle. Unit has completely sealed semi-metallic rectifier, and is used with three-phase power lines. Single current range adjusts output from minimum of 200 amp to maximum of 1600. Model can be used as a power source for heavy submerged arc welding, plasma jet process, gouging and some electric furnace applications. *Miller Electric Mfg. Co., Inc.*

Circle No. 14

Wheel balancer

REUTLINGER Electrodyn system for grinding wheel balancing can be attached to any machine, says manufacturer. It can be fitted to a single machine or to as many as eight machines which are controlled from master unit. Suitable, according to types used, to cover any weight of wheel and speeds from 400 to 30,000 rpm. In special cases it can handle speeds up to 120,000 rpm. Electronic part is interchangeable and suitable for continuous operation. *Wharton Unitools.*

Circle No. 15

Stainless solder alloy

AMBRAZE 4300 is for high capillary joining of steel, nickel, stainless steel, copper, Monel, aluminum-bronze, berrylium-copper, Elkonite and aluminum or any combination of these metals. Alloy complies with all Pure Food laws and is non-toxic. It can be used with torch or soldering iron. Melting point is 425 F, tensile strength is 14,000 psi and shear strength (copper to copper) is 11,200 psi. Comes on 1-lb spools in 1/16, 3/32 and ⅛-in. diameters. *American Brazing Alloys Co.*

Circle No. 16

You can see many of these new products on exhibit at the AWS Welding Show in Chicago's International Amphitheatre, April 7 to 9. And WE will look for you, too, at our booth—915.

Nuclear steels

NEW series of steels have weldability, formability and strength characteristics which make them usable in many nuclear and commercial fields. Steels are produced in plate, sheet, strip, bars, tubing, rods, wire and extruded shapes. Plasticity while cold of new series is its biggest advantage, says manufacturer. For example, a hot formed seamless tube of 2⅝-in. OD was reduced to ¾-in. OD tubing by cold drawing. Series has low manganese and cobalt content. *Jones & Laughlin Steel Corp.*

Circle No. 17

Diluter

PROPANE diluter automatically supplies accurate mixtures of propane and air or butane and air to maintain heat processing operations, space heating, water heating, cooking or refrigeration during periods of fuel cutoff. Available for all sizes of installations, diluters are interchangeable without having to adjust appliances or gas burners, says manufacturer. *Selas Corporation of America.*

Circle No. 18

Portable spectrograph

PORTABLE X-ray spectrograph is designed for applications which involve in-process controls of metals, alloys and chemicals, identification and sorting of metals, etc. Machine non-destructively determines identity of metal and percentage of elements present. With standard lithium flouride crystal instrument covers atomic scale from Titanium to Tin in K series, and from Lanthanum to Uranium in L series. Unit consists of gaging head containing ray source, and power supply. Samples can be checked in all positions. *Philips Electronics Inc.*

Circle No. 19

Electric furnace

TYPE 2100 Thermolyne furnace can be used as a salt bath, melting, vertical muffle and crucible furnace. Maximum chamber temperature for intermittent operation is 1,900 F. Basic unit includes a hexagonal furnace (115/230 volts, with a 6⅝ by 11½ in. chamber), stainless steel pot with cover, lifting handle and thermocouple in protection tube. Optional accessories include refractory ladle and chamber liner, and insulated cover. *Thermo Electric Mfg. Co.*

Circle No. 20

Grinding wheel

EXPANDING wheel for circular abrasive belts is self-balancing and maintains flat edge so it can be used for polishing and tool grinding as well as rough deburring. Wheel accommodates an abrasive belt 1¼-in. wide and 21-in. in circumference. Neoprene wheel is retained between, but is not attached to, side flanges. Comes in two models, one for any speed between 1,250 and 2,250 rpm, and one for speeds to 3,450 rpm. *Miller Products Co.*

Circle No. 21

Wear-O-Matic Hard Surfacing is 3 Ways Better

1 *Faster . . . More Economical*

The Wear-O-Matic process of semi-automatic hard surfacing is continuous welding with manual control of the arc. However, unlike manual welding with stick electrodes, there is no time consuming slag cleaning or electrode changes. Higher deposition rates, 3 to 5 times faster than stick electrodes, greater deposition efficiency, 85 to 95%, plus more available arc time add up to savings of 40 to 50% over manual hard surfacing with stick electrodes.

2 *Uniform Resistance to Wear*

The superior wear resistance qualities of Wear-O-Matic hard surfacing wires is the result of closely controlled manufacture, properly balanced alloys and fluxing agents, and precision drawing. Wear-O-Matic 7/64" diameter open arc wires are precision drawn to true wire diameter ± 0.002" and through drawing are densely compacted assuring an easier feeding wire that will not crush in the feed rolls or bind in the feed cable. Dense compaction and closely controlled fabrication combine to provide a weld deposit more uniform in chemistry and metallurgy resulting in uniform hardness and greater wear resistance throughout the deposit.

3 *Greater Efficiency and Ease of Application*

Here's a hard surfacing combination *designed* to cut maintenance cost through the *profitable* utilization of your welder's time. Wear-O-Matic wires in WELD-PAKS are the key to greater efficiency of both semi-automatic equipment and operator. Each WELD-PAK contains 100 pounds of wire packaged in a "dead cast" resulting in tension free, snarl free feeding. Because the WELD-PAK contains 2 to 4 times more wire than standard coils, the amount of time spent handling wire is lessened, providing more time for welding. WELD-PAKS are easier to handle and store; and on the job, the lid can be replaced after use assuring dirt and dust free wire when you are ready to resume welding. From set-up to finished job, the Wear-O-Matic process is easier and faster, eliminating overtime or providing more time for other maintenance jobs. Job test this time saving process in your own shop. Request Bulletin HS-102 for complete details. Alloy Rods Company, P. O. Box 1828, York, Pennsylvania.

Wear-O-Matic Wire Feed Unit
$279.00 f.o.b. York, Penna.
or El Segundo, Calif.

Weld-Pak is the trade name for this exclusive Wear-O-Matic package.

Alloy Rods Company

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QUALITY WELDING ELECTRODES FOR

- Stainless Steel
- Low Alloy Steels
- Cast Iron
- Tool Steel
- Bronzes & Dissimilar Metals
- Hard Surfacing Electrodes & Wires

NO FINER ELECTRODES MADE . . . ANYWHERE

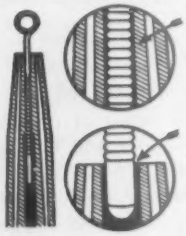
World's Finest CUTTING and WELDING TIP CLEANERS

WYPO
WIPES AND POLISHES

YOU GET SO MUCH MORE IN WYPO
Made of Stainless Steel

DOUBLES THE LIFE OF YOUR WELDING AND CUTTING TIPS

The exclusive circle design found only in Wypo Cutting and Welding Tip Cleaners provides as many as 60 more cleaning edges per inch of cleaner.



These rounded outer edges of cleaning ridges clean and polish tip orifice without scratching or cutting.

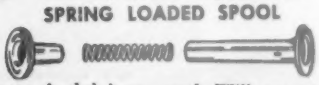
This smooth pilot guides WYPO Tip Cleaner into tip Will not enlarge or damage tip port.

This cross section view of WYPO Cleaning Surfaces shows these exclusive features:

Rounded cleaning surfaces that won't jam or cut.

Straight sided valleys insure thoro cleaning by removing all waste.

SPRING LOADED SPOOL

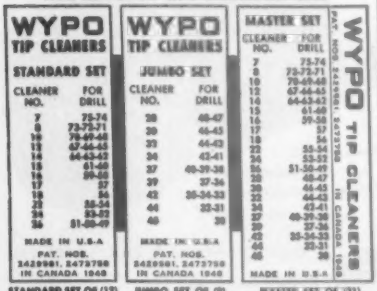


Spring loaded brass spool. Will not rust. Holds cleaners securely in case.

DOUBLE WOUND EYES

Insures longer life for small sizes of WYPO Tip Cleaners. Will not pull out of case.

NOW AVAILABLE IN 3 CONVENIENT SETS



Replacement cleaners available. Cleaning Range —Cleaner No. & Drill Nos. stamped on back of each case. WYPO GIVES YOU MORE!

SOLD BY LEADING WELDING SUPPLY DEALERS

WYPO
MAITLEN AND BENSON, INC.
1395 Cedars St., Long Beach 4, Calif.

Butt welder

MODEL B-1 butt welding machine can be used for lengthening screws, pins and rods, joining ends of saw blades, and joining the end of one reel of wire to another where a continuous wire production process is involved. Only a few seconds are required to make weld, says manufacturer. Clamping dies and welding transformer are not water-cooled, therefore machine is recommended for light or moderate production applications. *Peer Inc.*

Circle No. 22

Maintenance electrode

FLEETWELD 180, an E-6011 electrode for arc welding sheet metal and for general maintenance welding with small transformer welders, operates at currents as low as 50 amp. Its light slag makes it possible to weld 0.036 in. material without burn-through. However, when current is increased, arc becomes forceful and deep penetrating so it is suitable for general repair welding. Electrode is available in 3/32, 1/8 and 5/32 in. sizes. *Lincoln Electric Co.*

Circle No. 23

Turntable positioner

LOAD capacity of turntable welding positioner is 500 lb at center of gravity 6 in. above table surface and 3 in. off center of rotation. Infinite speed range is available from ¼ to 5 rpm. Heavy duty 110 volt d-c shunt-type motor is used with two-speed reduction gear box. Direction of rotation is reversible. Control panel comes mounted on frame, but can be remotely mounted. Table top can be tilted to 135 deg while loaded. *Miami Specialties Co.*

Circle No. 24

Cut-off saw

CUT-OFF saw is capable of length accuracy and cut parallelism within 0.003-in., says manufacturer. Spindle and vise are part of same casting. Special machining and checking methods permit final alignment of cut to within 0.001-in. in all planes of cutting operation. Saw cuts most ferrous and nonferrous metals, wood and plastic with use of two blades and fixed rpm. *Navan Products Inc.*

Circle No. 25

No Other Product Can Do a Galvanizing Job Like

Galvalloy

Does – HERE'S PROOF

Heat welded seam on galvanized sheet to 600° with Torch

Rub GALVALLOY against heated surface as shown — now spread with wire brush for a bright finish.

GALVALLOY Covers the Same Amount of Area with 1/5 the Amount of Material.

Send today for Testing Sample and you'll learn Why GALVALLOY has no equal for ANY Galvanizing Job.

METALLOY PRODUCTS CO.
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Here's Why The *Famous*

KEY-BAK
Key-Reel
SAVES WELDER'S TIME & MONEY

Retail $2.95

Welders who carry their flint-lighter on a KEY-BAK work faster . . . save, and make more money! Lighter is never lost. It's always handy at the welder's side, on his belt.

Get KEY-BAK for each welder. KEY-BAK is pocket-watch size, in highly polished chrome finish. Swedish clock spring reels in 24" long STAINLESS STEEL chain. LIFETIME GUARANTEE IN WRITING!

TWO MILLION KEY-BAKS NOW IN USE!

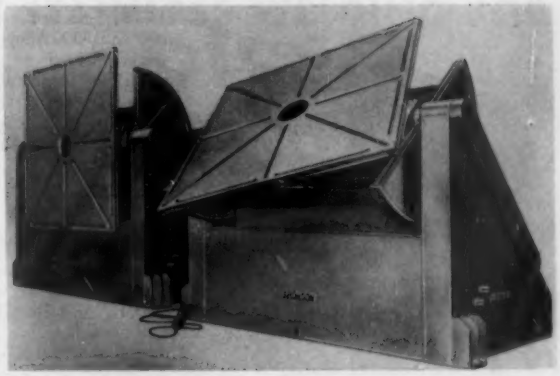
WELDER'S POUCH MODEL

Model 11-W designed especially for welders. Sturdy, genuine-leather pouch designed to hold chipping hammer and other tools. KEY-BAK attached to pouch. Pouch is worn on belt. Retails . . . $6.95

ASK YOUR JOBBER OR WRITE DIRECT!

West of Mississippi
BUMMIS MFG. COMPANY
2282 E. Foothill Blvd.
Pasadena, California

East of Mississippi
CTL COMPANY
1710 W. Stewart Ave.
Wausau, Wisconsin



Semiautomatic welder

HANDOMATIC is a semiautomatic welder designed for either open arc hardfacing or submerged arc welding. Unit has a universal semiautomatic wire feeder designed for hardfacing, build up and mild steel welding using tubular or solid wires. Connects to almost any welding machine, a-c/d-c. Single rheostat controls wire-feed speed, with a 60 to 260 ipm range. Cooling is provided by openings and side panel louvers. To remove wire reel assembly, it is necessary to remove only four bolts. Feed and pressure rolls, and current tips are available for 5/64 and 3/32-in. solid hard wire, and 3/32 and 7/64-in. tubular wire. Unit is designed for use with continuous current up to 500 amp using flux type or open arc gun. *Hobart Bros. Co.*

Circle No. 26

Respirator

SERIES C-200 respirator has an aluminum body, rubber face cushion, intake and exhalation valve. Single respirator plus interchangeable filters meet most industrial needs, says manufacturer. Filters are available for gases, vapors, dusts, mists, sprays, fumes and insecticides. *Pulmosan Safety Equipment Corp.*

Circle No. 27

Welding, cutting kit

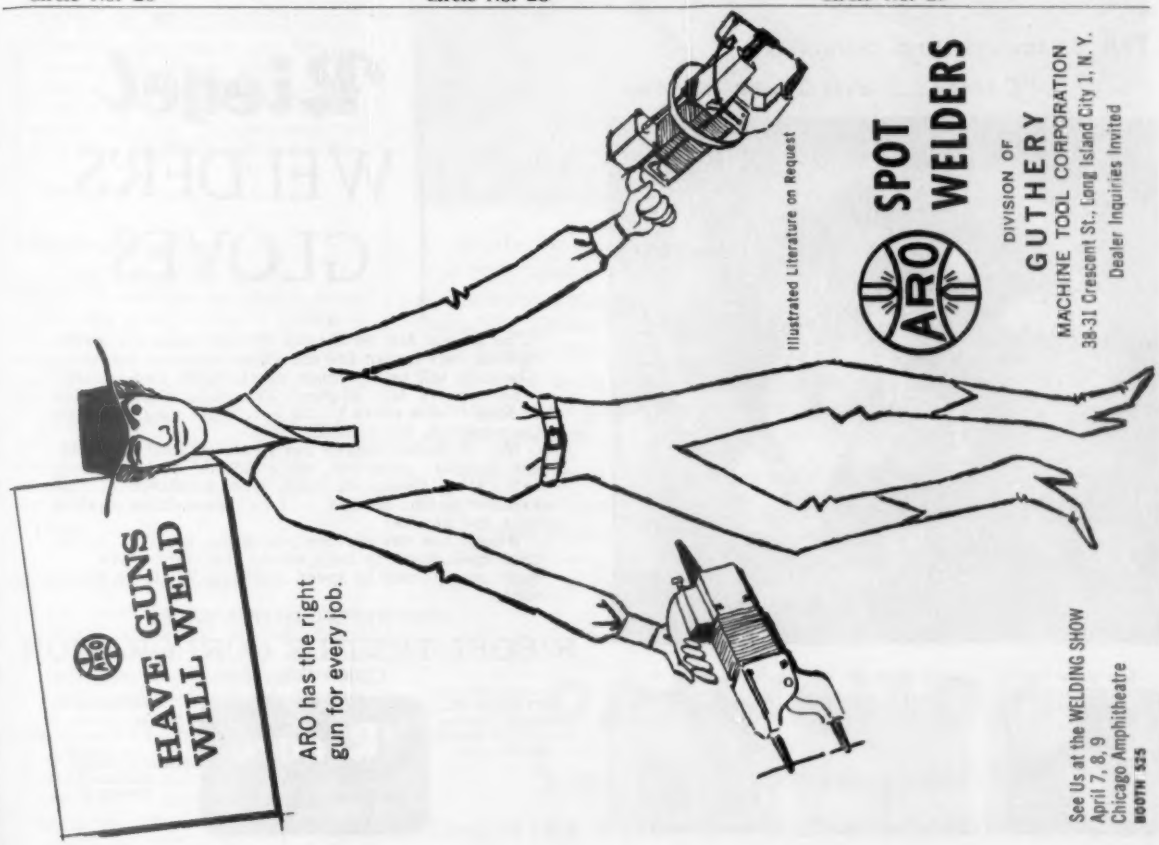
WELDING package contains Sifbronze General Duty Torch, Sifbronze Demon Cutting Torch, 10 welding nozzles and three cutting nozzles. Cutting nozzles range in size from 1/32 to ⅛ in. Unit comes in metal carrying case. *Suffolk Iron Foundry Ltd.*

Circle No. 28

Welding positioner

MODEL G850 gear driven welding positioner is designed to handle weldments up to 85,000 lb at 12 in. center of gravity location from workplate. Positioner provides for 90 deg forward-tilt and 45 deg back-tilt from table flat position. Four selective variable speed ranges are standard for rotating small diameter workpieces at 0.40 rpm as well as large diameters with speeds as low as 0.006 rpm. Horizontal axis is 85 in. above floor. Positioner can be used to position turbine assemblies, heat exchangers, submarine hull sections and other irregular shaped weldments. Includes a hollow spindle large enough for fixture use such as recessing hub of large gear blank. *Aronson Machine Co.*

Circle No. 29



Soldering gun

MODEL 8200K soldering gun, with dual heat control, comes in kit form. High and low heat, 90 and 125 watts, can be obtained. Gun is balanced to aid precision soldering. A pre-focused spotlight illuminates work while gun is in use. Tip is made of copper for good heat transfer and iron-plating for durability. Gun can be used for industrial, electronic, electrical or maintenance work. *Weller Electric Corp.*

Circle No. 30

No-corrode steel

ARMCO 22-4-9 is a new type corrosion and heat resistant stainless steel available as forging billets and rounds from ⅜ to 3 in. Steel can be used at temperatures of 900 to 1,600 F. At room temperature it has a controlled hardness between Brinell 300 and 350. Alloy can be welded by any methods used for stainless steel. Alloy needs no preheating or postheating and is said not to crack. Covered arc-welding electrodes of alloy composition have been used for hardfacing applications. *Armco Steel Corp.*

Circle No. 31

Starter enclosures

NEW "lock-off" device has been added to NEMA 4 and 12 enclosures for manual starters. By sliding stainless steel plate over "start" button and inserting padlock, starter can be locked in "off" position. Watertight industrial enclosures are designed for company B and C type integral horsepower manual starters. Silicon rubber boots over pushbuttons prevent entry of water, dust or coolant. *Square D Co.*

Circle No. 32

Toggle clamps

KNU-VISE tiny toggle clamps feature horizontal handles. Each clamp has a 100 to 150 lb clamping force, for a reach of ⅞ and 9/16-in. in front of base. H-100 series includes four models: H-100 with twin flange base; HL-100 with left-flange base; HR-100 with right flange base; SH-100 with straight base for side mounting. Spindle head in open position retracts beyond front of base permitting vertical removal of large parts. *Lapeer Mfg. Co.*

Circle No. 33

Tig torch

TIG (tungsten inert gas) torch is air-cooled and handles currents from 5 to 150 amp. Head is insulated with laminated glass cloth and silicon resin. Material is said to neither char nor soften. Lightweight cable remains flexible in all working temperatures, reducing operator fatigue, says manufacturer. *Wilson Equipment Corp.*

Circle No. 34

Welder Control

COMPANY has new NEMA N2 electronic welder control designed for general use. It provides features normally furnished with special automotive type control, says manufacturer. Optional functions, such as slope, post heat, forge, electronic firing of valve and contactor, are available as plug-in features. *Weltronic Co.*

Circle No. 35

This on-the-job test reports:

"Cooler . . . lasts 3 times as long"

Spot Welder No. 89

Service Welder No. 199

Welder's Mitten No. 98

Riegel

WELDER'S GLOVES

"The Riegel No. 99 Heavy Welder lasts six weeks against two weeks for the glove we used formerly. The men tell us it's more comfortable and cooler."

So reports Mr. Richard Thornell, whose switch to Riegel now saves $35.00 yearly per man at Oliver Corporation, Springfield, Ohio.

No. 99 facts: Heavy but flexible "flextan" welders' leather, gunn cut, wing thumb. Extra roomy, extra long. One-piece back, wool-insulated . . . all exposed seams welted . . . full protection against heat and sparks.

Riegel has the service you want, too . . . industrial specialists to help select the right style . . . eight warehouses to speed delivery. Write or phone today.

INDUSTRIAL GLOVE SALES

RIEGEL TEXTILE CORPORATION

CONOVER, N. C.

Sales Offices in:
Birmingham • Chicago
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Riegel
GLOVES THAT WEAR ON
WHERE OTHERS WEAR OUT

Warehouses in:
Chicago • Conover, N. C.
Detroit • Greenville, Ala.
Los Angeles
New York (Paterson, N. J.)
Oklahoma City
Portland, Ore.

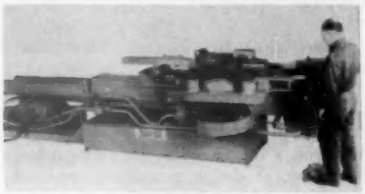
Film illuminator

HIGH-Intensity film viewer is used to read X-ray and Gamma ray radiographs. Unit can be used to examine 14 by 17 in. radiographs, smaller sizes and strip film. Three different round spots are readily accessible as is a continuously variable slit arrangement ideal for viewing weld radiographs, says manufacturer. Unit can read film densities as high as 4 h & d. Intensity is variable over wide range. Unit has variety of masks on high intensity spot, large air movement for cool viewing and foot control switch. *Princeton Div., Curtiss-Wright Corp.*

Circle No. 36

Bar bender

WALLACE No. 92 bends reinforcement bars to 2⅜-in. round capacity at approximately 7 rpm. Power of twin-cylinder drive is transferred to shaft by roller chain. Twin cylinders guarantee equal force for bending in either direction. Speed control valve is provided to permit bending of high-



carbon bars. Machine has foot-operated electric control. Degree of bend selector has four adjustable stops in each direction of rotation. Stops can be pre-set for desired angles of bend. A 30 hp motor may be wired for either 220 or 440 volts, three-phase, 60 cycles, a-c. Electric control circuit is 110 volts. *Wallace Supplies Mfg. Co.*

Circle No. 37

Aluminum wire

ALUMINUM welding wire 4043 is a filler material for both gas and electric fusion welding. Its principle alloying element is 5% silicon. It will effectively join such wrought alloys as 5052, 6053 and 6061, and many cast aluminum alloys. Because 4043 has a low melting point, 1,055 F, it produces a wide solidification range. This enables metal to fill voids without setting up stresses in parent metal, says manufacturer. Comes in 36-in. lengths, 1 and 10-lb spools. *Dalweld Co., Inc.*

Circle No. 38

Spherical corners

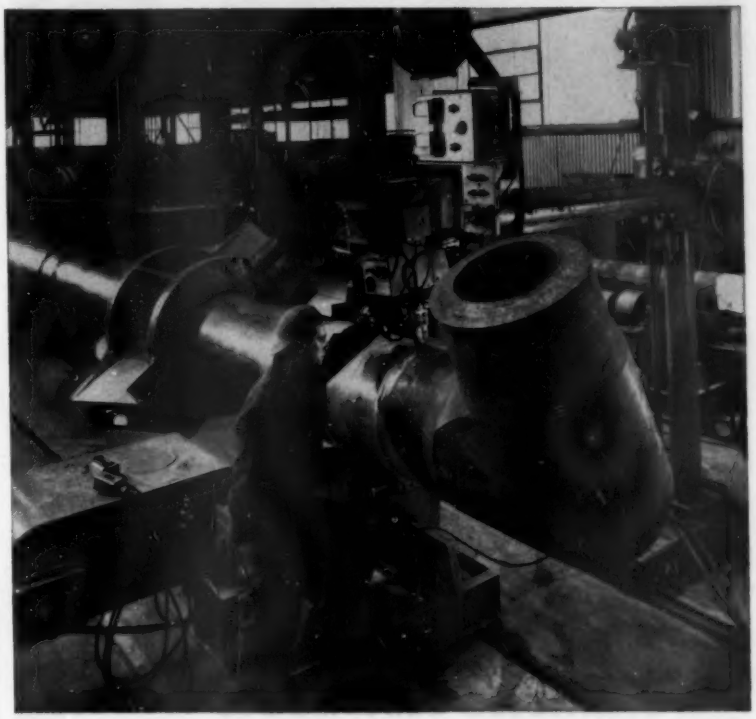
CONNER spherical corners are said to allow economical production of ball-cornered table tops, cabinets, etc., while improving product's appearance. Flanged corners come in stainless and mild steel and aluminum in 10 to 18 gage sizes, with radii sizes from ½ to 1½ in. When using, four edges of workpiece are notched and bent to a standard radius and welded into place. *Conner Steel Products.*

Circle No. 39

FOR ANY STAINLESS WELDING JOB

Drawalloy
CORPORATION

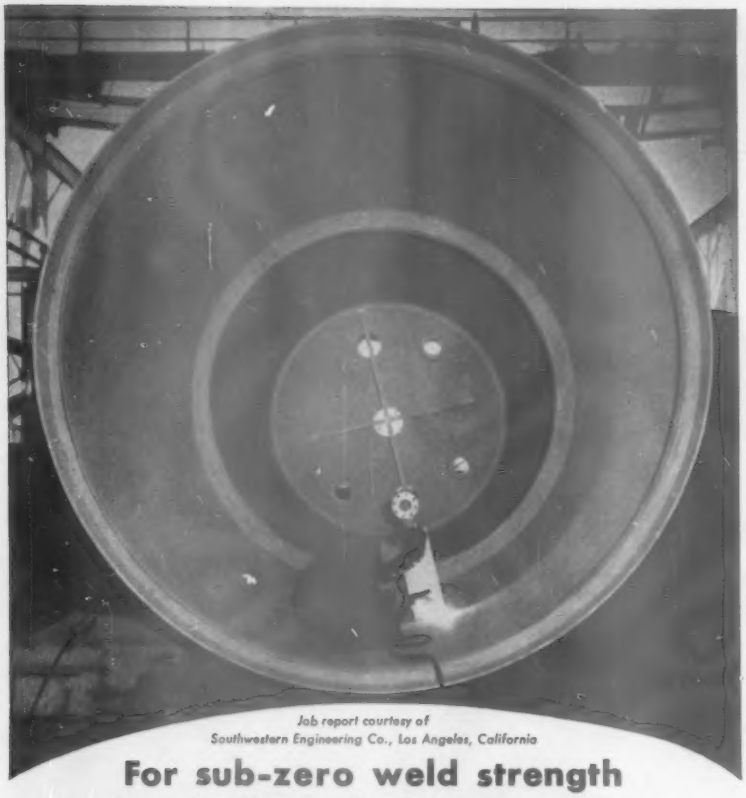
Stainless Steel Welding Wire



Specify Drawalloy "quality controlled" stainless steel welding wire for *your* next "quality weldments." Your greatest advantage is experience . . . our experience in producing wires for welding exclusively. Because we are specialists, Drawalloy stainless steel welding wire is produced to strictly controlled specifications to provide the right chemistry, finish and temper for the finest quality weld metal and smoother operation in your automatic or semi-automatic equipment. Drawalloy stainless wires are available in all popular grades as well as 2¼ Cr, 1 Mo; 1¼ Cr, ½ Mo.

Why not discuss your stainless welding wire needs with your Drawalloy Distributor or Representative . . . a man with the products and knowledge to help you. Bulletin 355 DC provides complete information on every grade of Drawalloy wire. Write to: Drawalloy Corporation, Lincoln Highway West at Alloy Street, York 12, Penna.

DRAWALLOY
CORPORATION
STAINLESS STEEL & TOOL STEEL WELDING WIRE
THE WIRE MILL FOR THE WELDING INDUSTRY



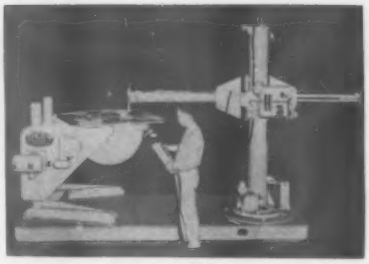
Job report courtesy of
Southwestern Engineering Co., Los Angeles, California

For sub-zero weld strength in missile fuel storage tanks

WELD WITH ARCOS

STAINLESS ELECTRODES

When completed, this tank will hold a liquid propellent fuel under 125 lbs. psi. Service temperatures will range from plus 200°F down to *minus* 300°F. The customer selected type 321 stainless for the vessel. To assure required impact strengths at extreme temperatures, Arcos STAINLEND 19/9Cb electrodes were recommended. This top quality weld metal joins the heads, shell seams, fittings and all attachments. Again—the tougher the test, the greater the need for Arcos. ARCOS CORPORATION, 1500 S. 50th Street, Philadelphia 43, Pa.



Mast and boom fixture

WEBB 360 deg mast and boom fixture provides high work load with minimum deflection, says manufacturer. Design permits longitudinal welding and welding head positioning. Hardened and ground steel ways are reversible and interchangeable. Vertical adjustment is made through an acme screw operated by a double reduction gear. Equipment includes overload and under voltage protection, 110 volt operator station and four-direction limit switch. Remote speed control and tachometer are optional. Vertically adjustable work table is mounted on ball race. *Webb Corp.*

Circle No. 40

Fire extinguisher

MONITOR, a dry chemical fire extinguisher, has spherical design permitting one-hand operation and accurate control of stream. Cartridges can be replaced immediately, offering uninterrupted fire protection. No pressure gage is needed because charge can be determined by weighing. Cartridge remains fully charged indefinitely, provided it has not been punctured. Hanging bracket is also a locking device to avoid accidental discharge. It is only dry chemical recharge unit approved by Underwriters' Laboratories, says manufacturer. *Ansul Chemical Co.*

Circle No. 41

Bending attachments

Two attachments further usefulness of Hossfeld Universal Pipe, Bar & Angle Iron Bender. Handrail capping can be bent into lambs' tongues, volutes and edgebends with No. 2 bender and special dies. No. 1 bender forms single and double turn scrolls. Single turn die comes in large and small sizes. Large die forms scrolls 4 in. in diameter, small die 2½ in. in diameter. Double die forms 6-in. scrolls. *Hossfeld Mfg. Co.*

Circle No. 42

Temperature indicators

TEMPILSTIKS, Tempilaq and Tempil Pellets for indicating 306 F and 319 F are available. New products are for determining temperatures of engine and machine parts during performance tests, for checking defective steam traps, in post-forming plastic surfaces and for monitoring power tubes and transistors. *Tempil Corp.*

Circle No. 43

Repair kit

PLASTIC-MASTIC, an epoxy-polyamide chemical compound, can be used to repair concrete floors, metals, masonry, cloth, paper products, pipes, plastics, ceramics, glass, rubber, bricks, etc. Kit consists of two cans, one containing a white base, one a black hardener. Equal parts of each are mixed to form gray composition. Base

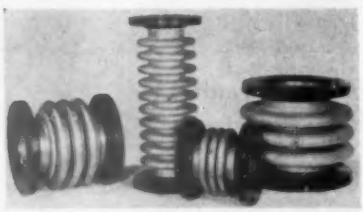
contains epoxy resin, hardener contains polyamide. Mix can be formed to fine edge, and in cured form, may be drilled or machined. Mix is non-flammable and contains no volatile solvents. At room temperature, composition is hard in 4 hours, can be walked on in 8 hours. Kit comes in quart, half-gallon and two-gallon sizes. *Williamson Adhesives Inc.*

Circle No. 44

Cylinder pallet

WELDON Pallet is designed to handle cylinders. Unit is available in four sizes: bottle capacities 12, 32 by 40 in.; 16, 40 by 40 in.; 20, 49 by 40 in.; and 24, 58 by 40 in. Unit can be equipped with chain or adjustable pipe retainer. *Weldon Industries Inc.*

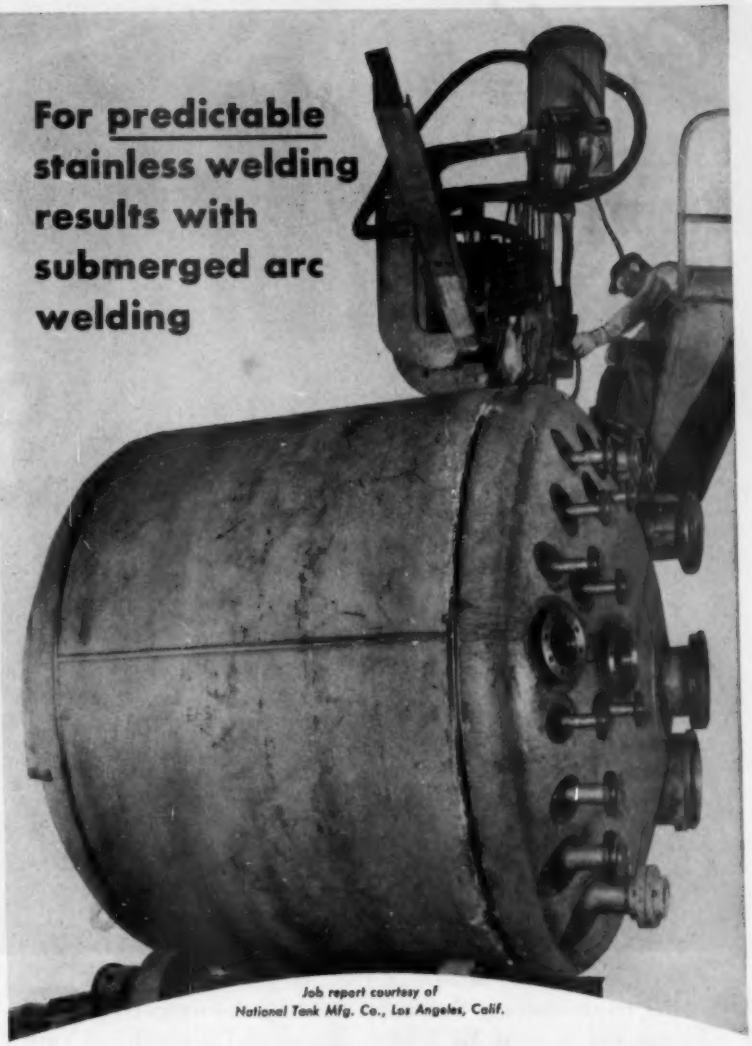
Circle No. 45



Expansion joints

STAINLESS steel bellows expansion joints come in 3 in. to 30 in. nominal pipe sizes for applications up to 275 psi and 750 F. Joints have test-rated cyclic life. Can be used where restricted space makes it uneconomical or impossible to install expansion loops to absorb expansion and contraction. Potential users of joints are petroleum, natural gas, nuclear energy, shipbuilding, aircraft and missiles industries. *Tube Turns.*

Circle No. 46



Job report courtesy of
National Tank Mfg. Co., Los Angeles, Calif.

use ARCOSITE BONDED FLUX

This 4,000-gallon tank for a resin reactor will handle highly corrosive material at temperatures of 500° to 600°F. Stainless top and bottom heads of type 316L were submerged arc welded to the body with Arcosite Flux and Arcos Chromenar Stainless Wire. This combination gives the proper weld metal chemistry for the needed corrosion resistance and an economical solution to the problem. ARCOS CORPORATION, 1500 S. 50th Street, Philadelphia 43, Penna.

Oxweld
TRADE-MARK

Flux-Coated Bronze Rod SAVES TIME!

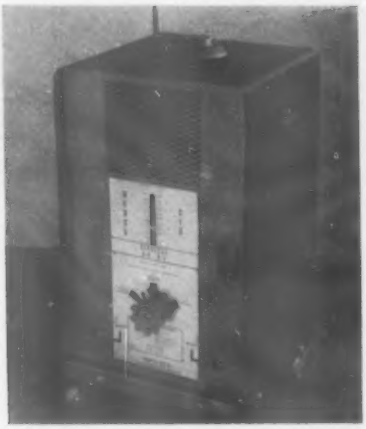
THIS triple-purpose OXWELD bronze rod is ideal for braze-welding steel, cast iron, and malleable iron; for building up wearing surfaces; and for fusion-welding brass, bronze, and copper alloys.

Welds made with OXWELD No. 25M rod average 40% stronger and are more ductile than welds made with ordinary bronze rods under similar conditions. Pre-coated during manufacture, OXWELD No. 25M Flux-Coated Rod automatically introduces into the weld exactly the right amount of flux to insure both thorough cleansing and uninterrupted tinning action. This speeds your work by permitting you to give full attention to deposit of weld metal and control of the molten puddle.

OXWELD No. 25M Flux-Coated Bronze Rod is available in 1/4-, 3/16-, and 1/8-in. diameters from your nearby LINDE Distributor. For further information write LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited, Toronto.

Linde TRADE-MARK
UNION CARBIDE

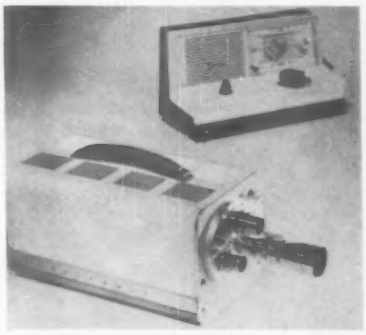
The terms "Linde," "Oxweld," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



Arc welder

LIGHT industrial type arc welder, model 210 a-c/d-c, is a combination rectifier, transformer and filter stabilizer. Standard model is a 5.5 hp, 220 volt single phase machine requiring a 60 amp fuse for 20 to 50 amp input. Model can use 1/16, 3/32, 1/8, 5/32 and 3/16-in. electrodes. Includes control wheel, on-off switch, and dial indicator for settings throughout a-c and d-c range. A-c scale has maximum 210 amp from 10 amp minimum with 77 OCV. In d-c range, knob selects either straight or reverse polarity. Scale has maximum 180 amps from 10 amp minimum with 77 OCV. A 440 volt model may be had by special order. *Birdsell Mfg. Co.*

Circle No. 47



Closed-circuit TV

ECONOMICAL closed-circuit television system is designed for schools, industry and commerce. Camera is a vidicon-type weighing 15 lb. It requires no special lighting and will transmit an image on channels 2 through 6 to any standard, home-type receiver. Camera is turret mounted for three different lenses, but may be bought with one, two or three lenses. *Sylvania Electric Products Inc.*

Circle No. 48

Small fixture clamp

COMPANY has added 2-in. fixture clamp to its Kant-Twist line. Addition has all features of larger clamps, says manufacturer. *Saxton Mfg. Co., Inc.*

Circle No. 49

Aluminum stud welding

NEW, portable stud welding equipment allows aluminum fastener studs up to ½ in. in diameter to be welded to aluminum plates. Aluminum stud welding eliminates such operations as manual arc welding, drilling, tapping and through bolting. Aluminum studs are end welded with NS-104 stud welding gun using special adaptor foot. An inert gas, either argon or helium, flows through foot and surrounds weld area. Special equipment meters and controls gas flow. Studs available, made from 4043 aluminum alloy, in lengths up to 3 in. and diameters of 3/16, ¼, 5/16, ⅜, 7/16 and ½-in. Tensile strength is 15,000 to 25,000 psi. *Nelson Stud Welding.*

Circle No. 50

Radiograph processor

X-OMAT automatic X-ray film processor delivers dry, ready-to-read radiographs in 13 minutes. Compact unit occupies approximately 26 sq ft of floor space, and extends 22 in. into darkroom. Most standard sizes of Type AA and Type M sheet and roll industrial X-ray film may be handled without adjustment. Fed three at a time, 4½ by 10-in. film is processed at approximately 560 sheets per hour. Large sheets and continuous film may also be handled. Unit has three sections: film loading station, processing section, and dryer. Developing solutions are automatically metered into tanks. *Eastman Kodak Co.*

Circle No. 104.

Aluminum holding furnace

NEW 30,000 lb aluminum induction holding furnace with three-section hydraulically operated cover is constructed for continuous service. Chamber lining is of monolithic construction and is non-wettable to aluminum. Pouring lip is located on axis of tilt, providing a constant pouring arc regardless of angle. Ladles or molds need not be shifted during pouring. Cover operates by means of hydraulic cylinders working at 750 psi. One or more sections can be lifted simultaneously, or entire cover can be removed for cleaning. Unit requires 350 kw, 480 volts, single phase, 60 cycles a-c for operation. *Lindberg Engineering Co.*

Circle No. 105

Arc welders

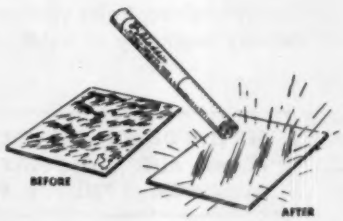
TM Idealarc, available either as a-c transformer welders or combination a-c/d-c rectifier welders, are for manual arc welding. They have mechanical, movable core reactor type of current control. Unit comes in NEMA rated 300, 400, 500 and 650 amp currents. Remote control of current and polarity, low voltage contactor, line contactor (starter) with overload protection and either a line- or 115-volt push-button, an arc booster, and power factor correction condensers are optional. Machines have a safe 73 OCV, yet produce stable arc with low a-c amperage and difficult-to-use electrodes, says manufacturer. Includes signal light, current control and polarity switch with durable silver contacts. *Lincoln Electric Co.*

Circle No. 106

Stamping machine

AUTOMATIC stamping machine for compressed or liquid gas cylinder shells can incise identification onto contoured shoulder surface of cylinder. Adaptors make it possible for machine to accommodate most sizes and shapes of cylinders. Loading, stamping and ejecting is fully automatic. Stamps single or multiple rows, and numbers cylinders in sequence or as desired. *Leonard Precision Products Co.*

Circle No. 107



Aluminum brush

FIBERGLASS brush is for removing aluminum oxides prior to soldering, brazing or Tig welding. Brush can also be used for friction tinning aluminum, and to clean most other metals, says manufacturer. *Aladdin Rod & Flux Mfg. Co.*

Circle No. 108

Your

LINDE Distributor

has it—

1. Service

Every authorized LINDE Distributor is an independent *local* businessman who knows your welding and cutting needs, has them ready for you, and satisfies you promptly.

2. Know-How

LINDE Distributors are welding supply *specialists.* Their technical background, practical experience, and knowledge of local industry can help you with your welding and cutting problems.

3. Superior Products

Your LINDE Distributor carries a *complete* line of industrial gases, equipment and supplies for your welding and cutting requirements. He handles only high-quality products of proved efficiency and best suited to your individual needs.

A telephone call to your nearby LINDE Distributor will bring you the benefits of more than 50 years of LINDE COMPANY's pioneering and leadership in welding and cutting. If you don't know your local LINDE Distributor, look in your classified telephone directory. Or write for further information to LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited, Toronto.

Linde UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Test fixture

MODEL *TTF* is a fixture to test strength of welded joints. It can be tooled to test small parts such as thermal elements, contacts and other electrical and mechanical components. Pull shear tests, both destructive and non-destructive, can be accommodated. Two models are available to handle tests from grams to over 100 lb. Torque wrench is used as measuring element. *P. A. Sturtevant Co.*

Circle No. 109

Temperature indicators

THERMOCOLOR comes in a variety of temperature-indicating pigments which change their original color when certain temperatures are reached. Material adheres to all types of metals, glass, brickwork, insulating and ceramic materials. It indicates temperatures over a range of 104 F to 2,912 F. Several thermocolor brands undergo one color change, while others undergo many changes. Temperature testing code is used with multi-color pigments. Powders are said to neither deteriorate nor decrease in accuracy over any period of time. *Curtiss-Wright Corp., Princeton Div.*

Circle No. 110

Liquid aluminum

DEVCON F-2 is a liquid aluminum material that can be cast without heat or pressure. It has 20,000 psi compression strength. Material bonds aluminum, steel, bronze, wood, ceramic and other material to themselves and each other. Devcon is said to be non-shrinking and non-expanding and abrasion resistant. It can be used to make inexpensive but durable core boxes, patterns, matchplates, jigs, fixtures, etc. *Devcon Corp.*

Circle No. 111

Carbide powders

MIKROCARBIDE includes complete line of carbide powders for hardfacing, abrasives, diamond settings, oil field tools, plastic dies and other applications where a wear-resistant material is needed. Hardness of the powders, composed primarily of sintered tungsten carbide, with small amounts of titanium and tantalum carbides in a cobalt binder for extra toughness, averages 91.5 Rockwell "A". Powders are available in bulk from 3 to 325 mesh. *Shwayder Chemical Metallurgy Corp.*

Circle No. 112

Time recorder

MELTIME Arc Time Recorder calculates incentive rates. It can be used to record arc time down to tenths-of-a-minute for Arcair operations. Unit records precise amount of time involved in any welding or gouging job, says manufacturer. *Arcair Co.*

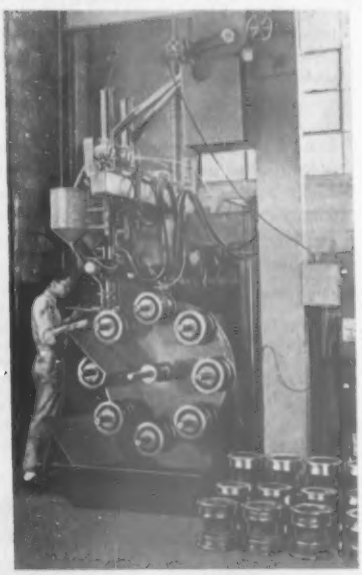
Circle No. 113

Horizontal grinder

PORTABLE horizontal pneumatic grinders can be used for weld dressing, buffing and wire wheel work. Models come in various sizes with speeds ranging from 3,100 to 12,000 rpm. Wheel sizes range from 3 to 8 in. in diameter. Lever, straight and grip-type handles may be had. *Thomas C. Wilson Inc.*

Circle No. 114

Revolutionary *Rexarc* Enables High Speed Production in Tractor Roller Rebuilding



(Pictured Above) A complete *Rexarc* installation at Michigan Tractor & Machinery Co., Detroit, Michigan.

Here is the new *Rexarc* MS-8 Automatic Twin Head Roller and Idler Welder and Positioner that mounts 8 rollers at a time. Hydraulic indexing enables virtually a continuous automatic welding operation. Twin heads build up both sides of roller simultaneously.

•

Factory engineer trains your operator, assuring excellent results from the very beginning of welding operations, at no additional cost.

•

SEE LIVE DEMONSTRATIONS OF THIS *Rexarc* MS-8 AND THE *Rexarc* AUTOMATIC FLUX CIRCULATING UNIT AT CHICAGO AWS SHOW, APRIL 7, 8, 9, BOOTH 433.

Phone, Wire or write today for complete information about this revolutionary profit-maker.

Manufactured by

THE SIGHT FEED GENERATOR COMPANY

SALES OFFICES AND FACTORY, WEST ALEXANDRIA, OHIO, U.S.A.

cranes during the construction of its Ravenswood, W. Va., sheet, plate and foil plant, in 1956. At that time 27 aluminum cranes were used.

Harnischfeger has had an overhead crane with welded aluminum components in operation and under test for two years.

Increased capacity without costly modifications of existing craneways and supports at Portsmouth is one of the major advantages of the aluminum cranes. In most cases, capacity can be increased from 25 to 30% over comparable steel cranes without increasing wheel loads. The Portsmouth aluminum cranes will have a 45-ton capacity, compared to only 20 tons possible with steel units.

Superior Propane buys H. May business

Superior Propane Ltd., Toronto, has acquired the propane business of H. May Ltd., St. Therese, Quebec. Acquisition includes May's propone storage equipment, tanks and regulating equipment.

Ohio State to hold summer welding engineering course

The Department of Welding Engineering at The Ohio State University, Columbus, will conduct a summer course on the Fundamentals of Welding Engineering from June 15 to 26.

The course will deal with all basic types of welding processes. Emphasis will be placed on the inter-relationships of the welding process, product design, production techniques and product quality.

Instructional staff for the course will include Prof. R. B. McCauley, chairman of the Department of Welding Engineering; Dr. R. C. McMaster, professor of welding engineering; and W. L. Green, instructor of welding engineering, and course supervisor.

Registration deadline for the course is June 8. Tuition is $150. No prerequisite training or experience is required.

Mathieson research center nears completion

The $4,000,000 metallurgical research center being built by Olin Mathieson Chemical Corp. at New Haven, Conn., is expected to be completed by the middle of this year.

The Metals Research Laboratories will include a special fusion welding department, and will service the corporation's metals division.

Automatic Welding opens training center

Automatic Welding Co., Waukesha, Wis., has opened a school for teaching the theory, techniques and methods of hardfacing and resurfacing using automatic welding processes.

Students are taught to resurface rollers, idlers, tracks and wheels, and how to hardface shafts and other equipment. Instruction is also given on the machining necessary to maintain original specifications after repair work is done.

A new building was erected to house the school.

Netherlands plant planned by High Voltage Corp.

High Voltage Engineering Corp., Burlington, Mass., is making plans to build a manufacturing plant at Amersfoort, The Netherlands, according to president Denis M. Robinson.

Locating manufacturing, sales and service facilities in Amersfoort will enable the company to provide additional services to present installations in Europe, the Near East and Africa.

The company manufactures radiation-producing particle accelerators.

Helex Co. to extract helium from natural gas

The Helex Co. has been formed by Northern Natural Gas Co., Omaha, and Air Products Inc., Allentown, to extract helium from natural gas.

The new corporation will build a $13,500,000 extraction and purification plant near Sunray, Tex. The plant will be able to process 120,000,000 cu ft of natural gas daily. This will bring a yield of 260,000,000 cu ft of helium a year.

RCA to service Gulton ultrasonic equipment

RCA Service Co., Camden, N. J., has been contracted by Gulton Industries Inc., Metuchen, N. J., to service all industrial and medical ultrasonic equipment manufactured and sold by Gulton's Vibro-Ceramic Div., which produces the Glennite line.

AUGUSTINE, Elmer and Valdimar Franco of Mexico City, left to right, are shown with E. Ortenstone and J. E. Smith, executive vice president of Smith Welding Equipment Corp., Minneapolis. Brothers were sent to Smith so they could learn their father's trade. Fernando Franco owns Compania Mexicana de Soldadura Autogena, S. A., a welding equipment distributorship. Brothers are engineering students at University of Mexico.

SCIENCE-in-industry program is conducted annually in Louisville to show high school teachers applications of scientific principles. Tube Turns of Louisville participates in program. Here, group watches as sample of metal, held in upper part of machine at left, is pulled apart to determine yield point and tensile strength. Data is compared to industry standards of material used in production of welding fittings and flanges for industrial piping.

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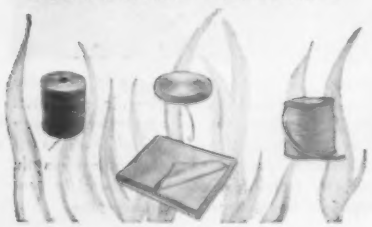


HEAT sink method of protecting delicate electronic components from damage during soldering was developed by Boeing Airplane Co. Water-saturated clamps, shown at right of soldering iron, protect components. Below, closeup of ordinary felt-lined clamps which are used in process. Clamp is attached to lead wire between soldered joint and component. Water evaporation dissipates heat which travels along lead wire from soldered joints.

Rolled Alloys to have Detroit factory

Rolled Alloys Inc., distributor of heat resistant alloy steels, will build a new plant on land purchased from Packard properties in Detroit.

The new plant will cover 43,000 sq ft of floor space, and will have two 10-ton cranes operating in an open bay 60 by 324 ft. The plant will be equipped with the latest materials handling facilities and cutting equipment.

The firm is planning a nationwide expansion program, but will retain its main headquarters in Detroit.

Solar integrates Des Moines operations

The Des Moines, Ia., operations of Solar Aircraft Co., San Diego, have been established as a fully integrated division of the company. Bruce A. Willsey is vice president and general manager of the new division.

Along with aircraft and missile business, some industrial fields requiring precision metalworking skills and advanced engineering will be entered by the Des Moines division.

Shipment of radioisotopes for peace increased in 1958

The Atomic Energy Commission recently announced that the amount of radioisotopes shipped from its Oak Ridge National Laboratory for use in peaceful applications of nuclear energy increased 37% during 1958.

Stanford Institute broadens missile research

Stanford Research Institute, Menlo Park, Calif., is broadening its program of research on high temperature materials for use in missiles. Heading the expanded program is Dr. Oliver Preston, who has specialized in strengthening metals by adding particles of stable compounds.

To aid the new research a large plasma generator has been installed. It will be used to study the behavior of new metals and refractory compounds with melting points above 6,000 F. *(See "Plasma heat—newest addition to welding's product lineup," Feb., p. 50.)*

Also joining the staff is Dr. H. Desy who will be engaged in fundamental metallurgy research on factors which control the strength of metals and alloys.

Kennecott building Baltimore plant

Ground has been cleared and preliminary construction work has started on Kennecott Refining Corp.'s 16,500-ton-per-month electrolytic copper refinery located near Baltimore.

The entire refinery is being engineered and built by the M. W. Kellogg Co., New York City, from Kennecott's project design.

NCG making cutting machine for shipbuilders

National Cylinder Gas Div. of Chemetron Corp., Chicago, is manufacturing a fully automatic plate flame-cutting machine that is expected to cut the cost of preparing patterns and cutting the huge steel plates needed in ship construction.

The first unit, known as the NCG Lumotrace cutting machine, is expected to be completed in June. The machine uses the Lumatrax principle of electronic tracing developed by Canadian Westinghouse. ("Electronic tracing: Cost-saver for flame-cutting," p. 56, Feb., 1959.)

The machine shape-cuts steel plate by having an electronic centerline follower move over a reduced-scale photographic image of the shapes to be cut.

US Steel to build two southern warehouses

United States Steel Supply Div., Chicago, is building two steel warehouses, one in Memphis, and one in Texas between Dallas and Ft. Worth.

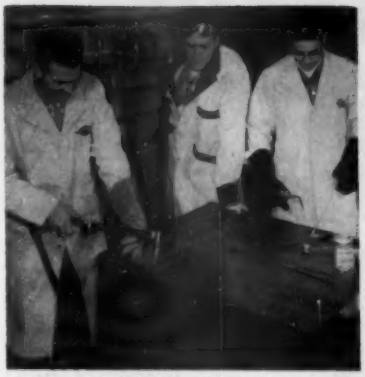
The steel-clad, one-story structures are expected to be completed this year. Both facilities will offer a full line of steel and aluminum, and complete strapping service.

A. O. Smith opens southern product service center

A. O. Smith Corp., Milwaukee, has opened a southeast branch product service building at 754 Miami Circle NE, Atlanta. Manager of the branch is J. A. Snyder.

The building, located in the Piedmont-Southern Industry Center, handles product service for Georgia, Mississippi, Tennessee, North and South Carolina, Alabama and Florida.

Also housed in the new building are the district sales offices for the company's Permaglas division, with F. K. Toney sales manager, and the area sales offices for Smith-Erie division, with O. E. Reedy sales manager. The company's welding products sales representative, J. P. Thomas, also headquarters in the building.



HERBERT C. WILSON, left, of Pacific Region, is about to use cutting torch as E. J. Vogel, technical sales director looks on. James E. Scott, of Seattle, prepares to make practice weld. Picture was taken in laboratory specially constructed for seminar on compressed gases held by General Dynamics Liquid Carbonic Div. for its field engineers.

Liquid Carbonic conducts compressed gases seminar

An engineering seminar on compressed gases was recently conducted for the field engineers and salesmen of General Dynamics Liquid Carbonic Div. at the company's Chicago plant, 4400 W. 45th St. Edward J. Vogel, technical sales director, headed the seminar.

Approximately half of the company's field engineers and salesmen enrolled in the course. A laboratory was specially constructed so participants could study the actual use of welding and cutting apparatus.

Other phases of the seminar covered new applications of liquefied gases, physical properties of gases, technical servicing of welding equipment, functions and design of regulators, industrial piping and compressed gas economics.

Tool engineer can help reduce honeycomb cost

Frank J. Filippi, project liaison engineer, Solar Aircraft Co., San Diego, presented a paper at the American Society of Tool Engineers Western Tool Show in Los Angeles, that said the tool engineer can help reduce the cost of producing honeycomb sandwich structures.

His paper, "Honeycomb sandwich fixtures at 2,000 F," explained the designer's role in the design and operation of tools and fixtures used in brazing. Filippi said that even in limited production tools and fixtures can be simplified, combined or eliminated in the fabrication of brazed honeycomb structures to reduce their cost.

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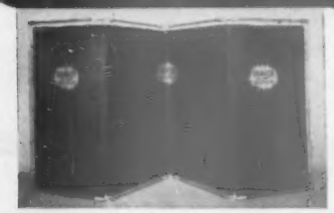

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WILLIAM Haile, right, president of Linde Co., presents certificate to Clark V. Howell, 200th graduate of company's distributor training school conducted at Speedway factory. Howell, manager of Tri-City Welding Supply, Bay City, Mich., completed five days of sessions on oxyacetylene and Tig welding, and medical oxygen equipment. W. B. Browning, coordinator of training, looks on.

Haile says oxygen production to exceed 80 billion cu ft

William M. Haile, president of Linde Co., New York City, says oxygen production in the United States will exceed 80 billion cu ft in 1959 —an increase of approximately 20 billion cu ft over 1958's output.

Haile, speaking to a group of distributor salesmen at a training course conducted at the company's Speedway factory and laboratory, also predicted welding distributors will handle more oxygen business and other products in 1959 than in 1958.

During his talk, Haile traced Linde's 52-year history, the development of oxygen distribution, and told how the welding supply distributor evolved.

He said, "The growth of the welding industry has been a phenomenon of the 20th century."

Quality control convention in Cleveland, May 25 to 27

The All Industry Production and Quality Control Exposition and the 13th annual convention sponsored by the American Society for Quality Control will be staged in Cleveland's Public Hall, May 25 to 27.

Taking part in the convention and exposition will be the armed forces of the United States. The latest missiles will be on display and key men from bases across the nation will be on hand.

Sessions will be held on military progress in quality control for 1958, new developments in military food inspection, missiles and outer space.

Superweld acquires stock of Western Carbide Corp.

Superweld Corp., North Hollywood, Calif., has acquired the outstanding stock of Western Carbide Corp. Hoyt Todd, former vice president and chief metallurgist of Western Carbide, will be associated with Superweld.

Western Carbide specializes in manufacturing hardfacing alloys and has been granted several patents in the metallurgical processing field. Superweld, a metal treating firm, is currently doing research work in the missile and aircraft fields.

New alloy may have missile, aircraft use

National Research Corp., Cambridge, Mass., has developed a new iron-aluminum-manganese alloy family which they say gives promise of eventually producing a low-cost, high-temperature alloy without use of strategic stockpile metals.

The firm says the new light weight alloys have good cold workability, high temperature strength and oxidation resistance—desirable qualities for missile, aircraft or automotive industry use.

Company officials say, however, that before the alloys are of real value to these industries more development is needed to achieve optimum composition.

Pullman-Standard offers car-conditioning program

Pullman-Standard Car Mfg. Co., Chicago, has developed a program that will allow railroads to obtain like-new passenger cars at one-third the cost of new equipment.

The re-manufacturing program has already been tried by North Western Railway Co., who is using 25 re-conditioned cars. The program uses plastics and other low cost materials that require little maintenance

New company to supply foreign products

Materials for Electronics Inc. will make available to the industry special-purpose chemicals, metals, ceramics, minerals and components. The company will headquarter in Jamaica, N. Y.

President of the firm is M. J. Rafale, former head of the Chemistry Section, Product Development Laboratories, Sylvania Electric Products Inc. Rafale says the company will supply its customers with products made in six foreign countries.

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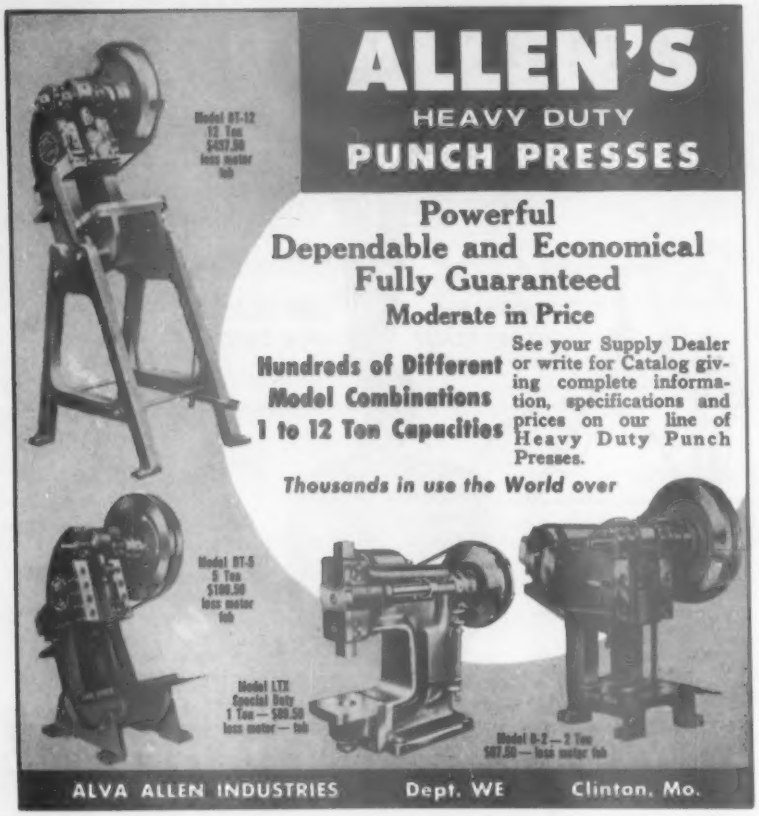
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Sylvania adapts sarong for tube purposes

Sylvania Electric Products Inc., New York City, has developed a way to coat the cathode of a tube to assure stable tube characteristics and lengthen tube life. The new coating, Sarong, is so named because it is a tight-fitting film that is wrapped around the cathode rather than sprayed on.

The cathode coating will be used in all types of electron equipment including television receivers, communications and processing equipment and electron systems for national defense.

Use of Sarong will result in maximum uniformity of the cathode covering. When spraying a liquid coating its thickness and distribution are not always uniform, thus varying the electron omission efficiency of the cathode. Sarong will assure a uniform coating, says Sylvania.

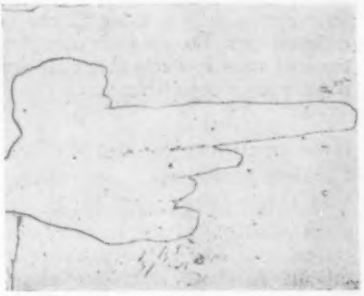
Burns & Roe to design Pan American buildings

A welding shop will be included in the new Pan American World Airways jet engine overhaul building to be built at New York International Airport under the supervision of Burns & Roe Inc., New York City engineers and constructors.

The 160 ft wide, 330 ft long building will also house machine plating, assembling and disassembling shops, offices and a small-parts storage area. The facility will be of steel and curtain wall construction, with a glass exterior and blue spandrel panels.

Another building, for testing jet engines after they have gone through the overhaul facility, will be a basic concrete, structure.

They went thataway



UNUSUAL metal grain structure of a nitrided zirconium crystal bar sample was discovered by scientists during routine examination at Bettis atomic power division, operated by Westinghouse Electric Corp. for the Atomic Energy Commission. Specific set of conditions that produced formation were intended to add 4% nitrogen to 25-gram sample in 3-in. tube furnace.

Hobart issues film on electrode coatings

Hobart Bros. Co., Troy, O., has issued a 16-mm sound movie covering the steps involved in mining minerals from the sea sands of Florida for electrode coatings.

"From sea sands to better welding," is available for loan, free of charge, from Hobart Bros. Co.

Connecticut adopts part of AWS standard

The Bureau of Industrial Hygiene of the Connecticut Department of Health recently reproduced a section of the American Welding Society standard, "Safety in welding and cutting," for distribution in the state.

Section 8 of the standard deals with fumes and similar air contaminants that may be given off during certain welding and cutting operations.

New welding process saves money, metal

Reclamation of scrap metal via a new welding process has saved one firm $70,000 on a single automotive stamping in one year. This is the claim of Precision Welder and Flexopress Corp., Cincinnati, who developed the process. The process involves welding odd-shaped off-fall into usable-size sheets on patented foil-butt-seam welding machines built by Precision.

The company says 39% of all sheet metal used in the automotive industry ends up in scrap, and much of this is not used. The new method takes otherwise discarded scraps and makes them into usable sheets.

Foil welding is said to produce smooth, non-overlapping seam welds of dense structure and high-strength —at speeds up to 24 ft per minute.

US Steel producing extra large steel plates

Extra large, heavy rolled steel plates for construction of Navy ships are being produced by the Homestead District Works of US Steel Corp., in Homestead, Pa.

The alloy plates, weighing nearly 50,000 lb, are rolled on a 160-in. plate mill. They are made in the large size to reduce the joining operations needed to construct a ship's hull.

After the plates are made and tested by the Navy to determine their protective and structural strength, they are flame cut to the exact size specified by the Navy.

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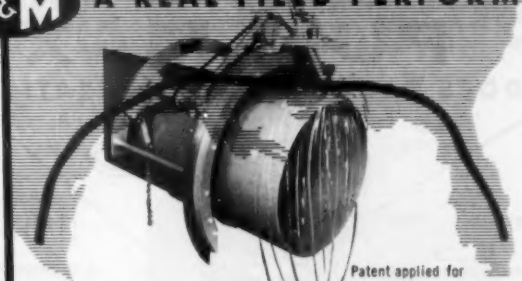

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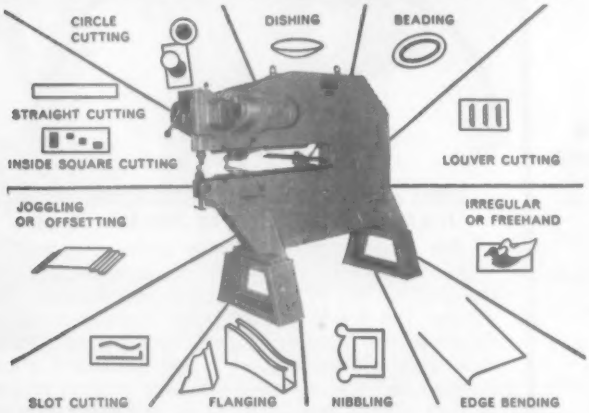

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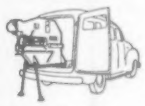

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Airline Welding awarded $47,000 in contracts

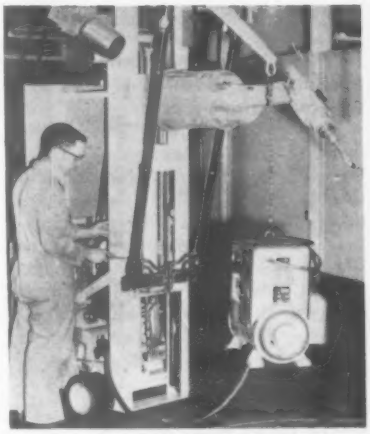
Airline Welding & Engineering Co., Hawthorne, Calif., has been awarded $47,000 in contracts for the design and construction of complete precision welding facilities for the manufacture of critical underwater ordnance devices.

The Naval Ordnance Test Station, Pasadena, Calif., awarded the firm a $25,000 contract for producing universal longitudinal and circumferential weld positioners and a weld roll planisher. Westinghouse Electric Corp., Baltimore, awarded Airline a $22,000 contract for design and construction of a specialized welding facility for fabricating aluminum underwater missiles.

Dip brazing facility built by Metalcraft

Meridian Metalcraft Inc., Whittier, Calif., has recently opened an aluminum dip-brazing facility for quantity production of aluminum assemblies, including the large sizes used in aircraft and missile construction.

Production equipment is enclosed in a 2,400-sq-ft concrete building along with the 45-cu-ft brazing tank. The main tank is 36 ft wide and 60 ft deep.



ENGINEER of Babcock & Wilcox Co.'s Atomic Energy Div., Lynchburg, Va., makes adjustment on largest of six-man robot "team" being developed to do maintenance and repair work in radioactive areas. Three-armed, three-ton mechanical monster stands 8 ft tall. It can thread pipe, and lift a 1,000 lb object 15 ft in air. Television camera, at left, will provide robot's human master with a clear view as robot performs. When completed, robot team will include pipe cutter, pipe welder that can make a high-integrity 6-in. weld in 30 seconds, tow truck, and 50-ton capacity crane, in addition to unit shown. All will be ultrasonically controlled from a shielded master brain control console.

Chicago finance company offers long-term loans

Commercial Discount Corp., Chicago, plans to inaugurate a program which will offer long-term (5-year) capital financing to growth corporations in the welding industry.

Sidney Feuchtwanger, president of the company, says the program will differ from bank loans in that the term is longer than any short-term commitment would allow. He adds that the new setup would involve no share of ownership of profits in the growth company, or voice in its management.

The new program will allow a minimum loan of $100,000 and a maximum loan of $1,000,000 to any one company.

New technique allows molybdenum spot welding

High strength sandwich structures for prototype applications are being fabricated by spot welding molybdenum sheets using a technique developed by T. R. Finn & Co., Inc., Hawthorne, N. J.

The new method produces a spot by fusing only the molybdenum in the immediate vicinity where the lapped sheets contact. Less than half the original sheet is affected by the weld, allowing the remaining material to retain most of its properties.

Thermographs used in honeycomb inspection

Experimental work done by Martin Co.'s Materials Engineering Div., Baltimore, indicates thermographs may be an accurate way to detect flaws hidden beneath skin of composite panels.

Dr. Samuel Katzoff developed the flow visualization technique which produces thermographs. A specimen's top surface is coated with an oil film and infrared heat is applied underneath. The heat traveling upward along the most conductive path displaces the surface film in a pattern that reflects the arrangement of the conductive material.

When applied to composite panels, the heat is conducted by the honeycomb core so the temperature pattern appearing on the top skin is a picture of the honeycomb core where it is joined to the skin.

Thermographs show irregularities in cell patterns, excess accumulation of brazing material at junctions and the intimacy of the core-to-skin contact. The specimen can be interpreted or photographed for later inspection.

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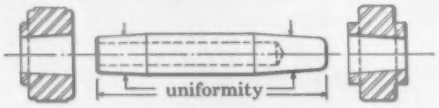

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Metal joining courses in session at Stevens

Two metal joining courses are among five new courses now being taught by the Industries Training School of Stevens Institute of Technology, Hoboken, N. J. The courses, which started in February, will last for 16 weeks.

The two metal joining courses are for light and heavy assembly work. The light assembly course is covering soldering, brazing and resistance welding of light gage wire and sheets.

The heavy assembly course covers some of the same processes but is concentrating on the various types of arc welding. Weld testing of electrodes available and welding equipment now used in industry are being discussed.

Both courses are being instructed by Isaac Goodman, metals joining engineer, Lamp Div., Westinghouse Electric Corp., Bloomfield, N. J.

USS building blooming and structural mill

The United States Steel Corp., is constructing a blooming and structural mill at its south works in Chicago. The mill will produce standard structural and lightweight wide flange beams.

A blooming mill for primary operations, preheating furnaces, a secondary or breakdown mill and a cross country 4-stand structural mill will be included in the facility.

Engineering services offered by Berlin

Arthur Berlin, Newark, N. J., has formed Automation Industries, an engineering design and equipment planning firm.

Berlin will also sell automatic welding fixtures and ram-type manipulators manufactured by C. B. Herrick Mfg. Corp., Cleveland. Berlin will cover the New Jersey, Delaware, eastern Pennsylvania and New York City areas.

University building named after inventor

The chemistry building being constructed on the University of Buffalo campus, Niagara Falls, has been officially named the Edward Acheson Hall of Chemistry.

Acheson, who died in 1931, was founder of the Carborundum Co., Niagara Falls. He did extensive research in electrochemistry and electrometallurgy and is credited with many inventions and discoveries in both fields.

Pipeline News

The Federal Power Commission has granted El Paso Natural Gas Co., El Paso, Tex., authority to construct and operate facilities that will enable the company to acquire additional natural gas in Lea County, N. M. Cost of additional facilities is estimated at $867,000.

Michigan Wisconsin Pipe Line Co., Detroit, has FPC authorization to construct 352.9 miles of 24-in. pipeline loops and add 16,560 hp in compressor capacity. Construction will be in Kansas, Missouri, Iowa, Illinois and Michigan, and will cost $31,157,000.

New York State Natural Gas Co., Pittsburgh, can build 27 miles of 20-in. transmission line from Elk County to Clearfield County, Pa., says the FPC. Cost will be $1,538,000.

Columbia Gulf Transmission Co., New York City, has FPC permission to build 11 miles of 12-in. lateral supply line and other facilities, at a cost of $820,000. Construction will be in Cameron Parish, La.

The Permian Co. was authorized to construct and operate facilities, at a cost of $3,681,000, so it can acquire gas from Emperor Field, Winkler County, Tex. Permian will build 60.9 miles of 16-in. lateral supply line, 11.3 miles of various diameter field lines and 9 meter stations.

FPC permission has been given Texas Eastern Transmission Corp., and its subsidiary, Texas Eastern Penn-Jersey Transmission Corp., Shreveport, to build pipeline facilities at a cost of $35,138,000. Texas Eastern will construct 28.8 miles of 30-in. pipeline loops, add to existing, and build new, compressor stations and build five new meter stations. Penn-Jersey will build 12.5 miles of 30-in. loop.

Distributor Appointments

Harnischfeger Corp., Milwaukee: Johnson Welding Supply Co., Hartford, Conn.

Allis-Chalmers Mfg. Co., Milwaukee: National Induction Heating Co., Hazel Park, Mich., (distributor of Allis-Chalmers induction heaters).

Kaiser Aluminum & Chemical Sales Inc., Oakland: Balaam Bros., Emeryville, Calif., (distributors of King Brand aluminum welding wire).

Electric Ark Inc., Newark: John D. Williams Export Corp., New York, N. Y., (distributors of Smith-Dolan induction heating equipment).

Nu-Matic Grinders Inc., Cleveland: Wm. N. Lowe Co., Detroit.

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About people . . .

Falk

Warwick

Pressing

Omundson

Tage Falk, formerly chief engineer for Smith Welding Equipment Corp., Minneapolis, has been named manager of product research and development for the firm. A native of Sweden, Falk came to the United States in 1952, the year he joined Smith.

The newly created position of assistant to the general manager—production activities, at the Page Steel & Wire Div., American Chain & Cable Co., Inc., has been filled by *C. Laurence Warwick, Jr.* He will headquarter in the company's main plant at Monessen, Pa.

Joseph I. Doherty has been appointed manager of the Whitehead Metals Inc., Windsor, Conn., office and warehouse.

Rankin Mfg. Co., Alhambra, Calif., has advanced *J. H. Holcin* to Eastern regional manager in charge of sales of Ranite hardfacing rods and Ranomatic wire.

John N. Ludwig, Jr., has been appointed supervisor of metallurgical services by International Nickel Co., Inc., New York City. He was formerly with the Electro Metallurgical Co., a division of Union Carbide Corp.

New field sales manager for the Sylvania Electric Products Inc. Chemical and Metallurgical Div. is *Byron L. Clark*. He will headquarter in Towanda, Pa.

Oscar H. Oberschmidt, production superintendent in charge of sheet metal, plate fabrication and equipment assembly at Baker Perkins Inc., Saginaw, Mich., has retired. While at Baker Perkins, Oberschmidt instituted many production welding inovations and was active in the American Welding Society.

Robert W. Pressing has been appointed general manager of the new products department, Linde Co., New York City. He was manager of Molecular Sieves Production and Development. *R. A. Jones* has been named sales manager, Molecular Sieves. He had been manager of market development for the absorbent, synthetic crystalline zeolites. At the same time, Linde made four appointments on the west coast. The following have been named managers of distributor sales: *Edward P. Miller*, Los Angeles district; *Donald H. Thorpe*, San Francisco district; *Edward W. Scott*, Pacific Northwest district. *John W. Dickinson* has been named manager of electric welding engineering in the Pacific Northwest district, with headquarters in Seattle, Wash.

The president of the recently formed Cardox Div. of Chemetron Corp., Chicago, *Roy T. Omundson*, has been elected a vice president of Chemetron. He was president of Cardox Corp. for 14 years before it was combined with the carbon dioxide activities of National Cylinder Gas Div. of Chemetron.

New manager at the Milwaukee district office of National Cylinder Gas Div. of Chemetron Corp., Chicago, is *Clarence H. Reinecke*, former assistant manager. He replaces *A. L. Breyvogel*, who recently retired after 18 years with the company.

Fred G. Outcalt has been appointed sales manager, Linde Department, Union Carbide International Co., Div. of Union Carbide Corp. He was assistant manager of Linde's electric welding department. Outcalt has been issued several patents on submerged arc equipment and methods.

Walter E. Stewart has been appointed product engineering director of the American Welding & Mfg. Co., Warren, Ohio.

P. A. Haythorne has been appointed technical director for Superweld Corp., North Hollywood, Calif. He was formerly chief engineer and manager of product development for the Aircraft Div. of Rheem Mfg. Co. He at one time was connected with P. R. Mallory Co.

Leland P. Clemens has been appointed Cleveland district manager of the Johns-Manville Celite Div. He succeeds *R. J. Amberg*, who has been transferred to the company's New York City office to head cement additives sales.

Donald F. Hastings has been named district manager in Moline, Ill., for the Lincoln Electric Co., Cleveland. *Donald G. Wright* replaces Hastings as a welding engineer for the company in San Francisco.

Chicago Bridge & Iron Co., Chicago, has transferred *Richard D. Ayers* to its Boston office, *Robert L. Blandford* to Tulsa, *James T. Dunn* to Philadelphia and *Donald F. Simons* to Chicago. In another move, *William C. Roberts* was appointed superintendent of the company's Greenville, Pa., plant.

Walter T. McCoy, Jr. replaces the retired *Eugene Bordinat* as manager of R. C. Mahon Co.'s New York City industrial sales organization.

Donald C. Burnham has been named by the American Society of Mechanical Engineers to receive the Richards Memorial Award for achievement by a young mechanical engineer within 20-25 years of graduation from college. Burnham is vice president in charge of manufacturing for the Westinghouse Electric Corp., Pittsburgh. He was formerly with the Oldsmobile Div. of General Motors.

Dr. Carl Buck will coordinate the metallurgical and technical aspects of production and customer service activities related to steels for missiles and missile equipment in a newly organized section of United States Steel Corp., Chicago.

Ralph M. Johnson has retired as director of sales for Norton Co., Worcester and of Behr-Manning Co., Troy, N. Y., a Norton subsidiary. At Norton's stockholder's meeting *George N. Jeppson* was re-elected chairman of the board and *Milton P. Higgins*, president. Johnson was re-elected a director and vice president.

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Edmund W. Dugan, business manager for Chemetron Corp.'s Girdler Catalysts operation in Louisville, has been appointed assistant director of the General Industrial Equipment and Components Div. of the Business and Defense Service Administration, U. S. Department of Commerce. He is on a six month assignment in Washington.

Dr. C. R. Castor is the new western sales engineer for the crystal products and rare gases of Linde Co., New York City. He has recently been engaged in research work in welding, high current arcs, crystals and combustion.

Albert P. Gagnebin has been elected a vice president, and *Joseph M. Weldon* an assistant vice president, of the International Nickel Co., Inc., New York City. Gagnebin is a mechanical engineer, author of a book on the fundamentals of iron and steel castings and many technical papers. Weldon, with the company since 1927, is a member of the American Society for Metals.

Assistant to the president of Gulton Industries Inc., Metuchen, N. J., is *J. Paul Jordan*. He was associated with General Electric Co. as a consulting engineer. He has written several papers, is owner of six patents, and has taught electronic theory at Union College.

The position of director of research and development for Dravo Corp., Pittsburgh, left open by the retirement of *W. L. Newhall*, has been filled by *Robert Hughes*. His assistant is *Dr. John A. Anthes*.

Two appointments have been made by the Diamonite Products Mfg. Co., Shreve, Ohio, a division of United States Ceramic Tile Co. *Edwin J. Rogers* is the new general manager and *R. C. Mulligan* the new sales manager.

Honorary membership to the American Society of Mechanical Engineers has been awarded four men. *John Blizard*, Foster Wheeler Corp., *Howard Coonley*, professional engineer; *James Gleason*, Gleason Works; and *Ernest L. Robinson*, formerly of General Electric Co., received the Society's honor.

H. E. Robison has been elected president and treasurer of Wheel Trueing Tool Co., Detroit. He succeeds *H. B. Wallace*, founder and president of the company since its inception in 1910, who is now chairman of the board.

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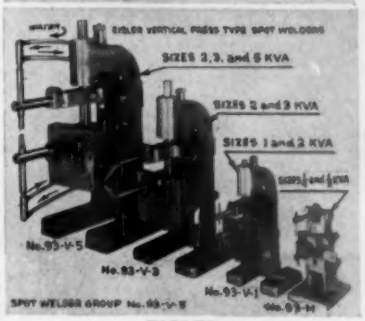

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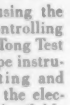

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St. John X-Ray Laboratory, Califon, N. J., has appointed *C. F. Safford, Jr.*, representative for film badge service in Michigan, Ohio and western Pennsylvania.

Died . . .

Merrill "Ken" Good died suddenly January 25, after suffering a heart attack. He was 47. Mr. Good was manager of electrode sales for Hobart Bros. Co., Troy, O. He was a member of the American Welding Society.

Paul Klain, 49, a group leader in the Metallurgical Laboratory of the Dow Chemical Co., Midland, Mich., and an authority on the welding of magnesium and its alloys, died March 3 in the Cedars of Lebanon Hospital, Los Angeles. Death was attributed to a heart attack. Mr. Klain authored many technical papers and was holder of three patents in the field of magnesium welding. He was a member of AWS and ASM.

Raymond F. Sherwin, 60, manager of the Welding Rod Division of Chicago Hardware Foundry Co., North Chicago, Ill., died March 9 in Victory Memorial Hospital, Waukegan, Ill. Mr. Sherwin was a member of the company's board of directors. He was considered an expert on the welding of castiron, and belonged to the American Welding Society's committee on joining iron castings. Mr. Sherwin developed a new type castiron copper-nickel rod while with the company. He is survived by a son and brother.

The executive vice president of Eutectic Welding Alloys Corp., Flushing, N. Y., *W. Sigmund*, died February 28. Mr. Sigmund had been with the company for the past 17 years. He used his knowledge of international banking and finance while working with the world-wide operations of the company.

Vern V. Miller, 71, died in Pompano Beach, Fla., March 16, after a brief illness. Mr. Miller was one of the Midwest's pioneer distributors of arc welding equipment. He was a Hobart distributor in Milwaukee for nearly 30 years, and retired to Florida five years ago. Surviving is the widow, a son, Vern, president of H. K. Miller Inc., Chicago, and a brother, Harry.

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book reviews . . .

Industrial mathematics

MATHEMATICS FOR INDUSTRY. By S. E. Rusinoff. Published by American Technical Society, Chicago, 1958. Cloth, 5½ by 8½ in., 565 pages. Price, $6.25.

"Mathematics for Industry," is written to refresh the reader, or introduce him to mathematics he needs in the shop.

The book begins with a review of arithmetic, and follows through with algebra, geometry, trigonometry and logarithms. There are also chapters treating special subjects, such as the mathematics of screw threads, gears, engineering computations and the use of graphs to solve engineering problems.

Rusinoff, a practical engineer and teacher, has called upon his shop experience to introduce principles having ultimate application in practical shop problems. Each principle is developed step-by-step, and each problem selected because of its practicability.

The clear, concise manner in which the book is written makes it helpful to anyone in the shop. However, it would have been more useful from a welding standpoint had the the author devoted as much attention to the strength of welds, as he did to the strength of rivets.

The appendix, with its many useful tables including natural trigonometric functions and logarithms of numbers, adds to the book's value.

Ultrasonic welding

ULTRASONIC WELDING OF STRUCTURAL ALUMINUM ALLOYS. By J. B. Jones and E. E. Weismantel. Published by Office of Technical Services, U. S. Department of Commerce, Washington, 1957. Paper, 8 by 10½ in., 88 pages. Price, $2.25.

This book is a report on research work undertaken by Aeroprojects Inc. for the Bureau of Aeronautics, U. S. Navy.

The report is divided into six chapters which include some background of ultrasonic welding, development of ultrasonic welding equipment, equipment development evaluation, ultrasonic room temperature welding of 2024 and 7075 aluminum alloys and ultrasonic elevated temperature welding.

Continuous seam type welding of structural aluminum alloys is discussed in the latter chapter. It is pointed out that surface cleaning is less critical prior to seam welding than it is prior to aircraft quality resistance spot welding. The chapter also states that when welding aircraft structural aluminum alloys the heating of parts below critical levels was found to be helpful.

Building construction

FIELD INSPECTION OF BUILDING CONSTRUCTION. By Thomas H. McKaig. Published by F. W. Dodge Corp., New York City, 1958. Cloth, 6 by 9 in., 337 pages. Price, $9.35.

"Field Inspection of Building Construction," is a must for contractors and field inspectors. It will also aid sub-contractors and fabricators engaged in construction activities.

The book begins with a discussion of the inspector's job, and then details the preliminary, foundation, structural framing, intermediate and final stages of construction.

The responsibility for such matters as quality of material, workmanship, coordination of work of different trades, scheduling, etc., are defined.

While only three pages are devoted to the inspection of welding, as compared to over 60 on the inspection of concrete, the book still contains much useful information for the steel fabricator.

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Welding symbols

WELDING SYMBOLS. Published by American Welding Society, New York City, 1958. Paper, 6 by 9 in., 88 pages. Price, $3.

For the first time since 1946 the AWS welding symbols have been revised. New symbols have been developed to keep pace with advancing welding technology.

Use of the symbols has been simplified by showing the desired weld and the symbol that will result in its reproduction. This will eliminate most of the confusion. However, some additional clarification could be used in the case of welds which are backed up.

One feature of the book is an alphabetical system for designating welding and cutting processes. Another table is for identifying welding methods, such as automatic, manual, etc.

In welding design, if the engineering is to be done in the engineering department, the AWS welding symbols should be an essential part of the engineering library.

Low alloy steels

TENTATIVE SPECIFICATIONS FOR LOW ALLOY STEELS. Published by American Welding Society and American Society for Testing Materials, New York City, 1958. Paper, 6 by 9 in., 16 pages. Price, $0.50.

This specification, which is a revision of the 1954 edition, covers E70XX, E80XX, E90XX, E100XX, E110XX and E120XX series of low alloy steel arc welding electrodes. The principle change on this standard from the previous edition is the inclusion of EXX18-X iron powder low-hydrogen type electrode.

Tabular information in the specification gives data on electrode specifications, chemical requirements, minimum tensile strength, ductility requirements, standard lengths and sizes and a summary of mechanical tests. Preheat interpass, stress relief temperatures and the requirements for preparation of fillet weld test assemblies are included.

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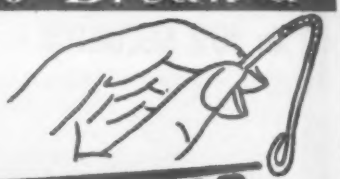

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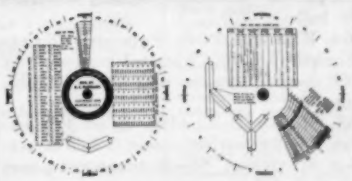

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51. MIDGET TORCH—Argopen Co. Flyer describes Argopen Model B, an inert gas air cooled torch for fine weldments on light gage metals.

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68. HYDRAULIC VALVES—Servocontrol of Oilgear Co. Booklet 36100 explains and illustrates electrohydraulic valves up to 3,000 psi

69. ELECTRODES—Champion Rivet Co. Catalog 57A is a 40-page book describing completely the company's full line of welding electrodes for all purposes.

70. TUNGSTEN ELECTRODES—Tec Torch Co., Inc. Sheet 303 gives diameter, finish and type of all company tungsten electrodes. Prices are included.

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96. RESISTANCE WELDERS—Alphil Spot Welder Mfg. Corp. Company has standard specifications chart on its line of resistance welders designed for sheet metal, wrought iron and tubing industries.

97. CONNECTIONS PACKAGE—Burdett Oxygen Co. New packaging system for Gateway connections is explained in circular.

98. METAL MELTING—General Electric Co. Bulletin GEA-6113A tells how to select cast-in immersion heaters, controls and melting pots for soft-metal melting applications.

99. GERMANIUM — Sylvania Electric Products Inc. Report describes physical characteristics and purity standards of germanium and germanium dioxide used in manufacturing semiconductor devices.

100. ENVIRONMENTAL TESTING—Philips Electronics Inc. "Low temperature production and control in environmental testing and application facilities," covers heat transfer systems, cold gas transporting and applications of Norelco cold circulating gas refrigerator.

101. WELDING GUIDE — Arcos Corp. "Welding guide and catalog," is designed to aid weldor in electrode and rod selection.

102. RESISTANCE WELDING — Resistance Welding Alloy Association. Leaflet covers money-saving advantages of resistance welding in production.

103. SEAMERS — Pandjiris Weldment Co. Catalog 5158 details and pictures company's internal and external seamers.

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(Continued on page 136)

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BUSINESS REPLY CARD

First Class Permit No. 32, Morton Grove, Ill.

Welding Info-Aids,
Welding Engineer
P.O. Box 28
Morton Grove, Ill.

Literature offered in ads

(Continued from page 134)

185. National Welding Equipment Co.—Catalog No. 16 available on the triplex oxygen regulator for three hose flame cutting torches.

186. Norris-Thermador Corp.—Further information available on acetylene cylinders.

187. Norton Co.—Write for further information on Norton's abrasives.

188. Page Steel & Wire Div.—Welding wire packaging chart, welding wire comparison chart, submerged arc and inert gas welding wire folder and a gas welding rod booklet are available.

189. Phelps Dodge Copper Products Corp.—Further information on Phelps Dodge "Habirprene" arc welding cable.

190. Picker X-Ray Corp.—Information on new roving units for on the job isotope radiography.

191. Riegel Textile Corp.—Data available on Riegel weldor gloves.

192. Ruemelin Mfg. Co.—Write for detailed information on the Ruemelin fume collector.

193. Shawinigan Products Corp.—Information on calcium carbide and name of your local distributor.

194. Shoot-A-Lite Corp.—Literature on "Safety Gas Liter" for welding and cutting torches.

195. Sight Feed Generator Co.—Write for complete information on the "Rexarc" automatic flux circulating unit.

196. Singer Glove Mfg. Co.—Catalog available on Singer's welding gloves and safety clothing.

197. A. O. Smith Corp.—Further information available on Smith's comprehensive line of electrodes.

198. Stoody Co.—Write for further information on Stoody semi-automatic hardfacing.

199. Stulz-Sickles Co.—Complete details on "Manganal" wedge bars and name of local distributor.

200. Tec Torch Co., Inc.—Full information available on the "Visuweld" torch, the Tec spot gun and Tec spot control.

201. Tempil Corp.—Information available on "Tempilstik" and sample of Tempil pellets.

202. Tennessee Fabricating Co.—Write for catalog "Everything for the Ornamental Iron Shop."

203. Thermacote Co.—Information on Thermo Tip cleaners.

204. Tuffaloy Dept., Air Reduction Sales Co.—Catalog and prices on Tuffaloy spot welding tips, tip holders and adapters.

205. Tweco Products Co.—"Twecolog" showing the complete line of Tweco accessories available.

206. United Specialties Inc.—Information on "Weldreel" hose and cable reels.

207. Vacuum Tube Products—Write for further information on resistance welding of light-gauge metals, with Vacuum Tube Products new mobile welder.

208. Victor Equipment Co.—Information on semi-automatic wire and profitable dealerships open.

209. Victor Equipment Co.—Descriptive bulletin 353 available on cutting machines.

210. Westinghouse Electric Corp.—Information on the "Baltospot" portable x-ray equipment for good radiographs is available.

211. Westinghouse Electric Corp.—Write for more information on the "RCV" Welding Power source with built in Dynamic Reactor.

212. Worthington Corp.—More information available on Worthington's positioning equipment.

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BUSINESS REPLY CARD

First Class Permit No. 32, Morton Grove, Ill.

Welding Info-Aids,
Welding Engineer
P.O. Box 28
Morton Grove, Ill.

Name_____ Title_____

Company_____

Address_____

City_____ State_____ 4/59

NOT GOOD AFTER JULY 1, 1959

WELDING ENGINEER, P. O. Box 28, Morton Grove, Ill.

Please send me without obligation further information about the following:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
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WARNING!

Illegible or incomplete addresses may keep you from receiving the information you desire. And remember, cards postmarked after the deadline date cannot be processed.

★ **Post card not valid after three (3) months. After that, write *directly to the manufacturer*, describing fully the information and/or literature wanted.**

DOWN-TO-EARTH FACTS about ground clamps

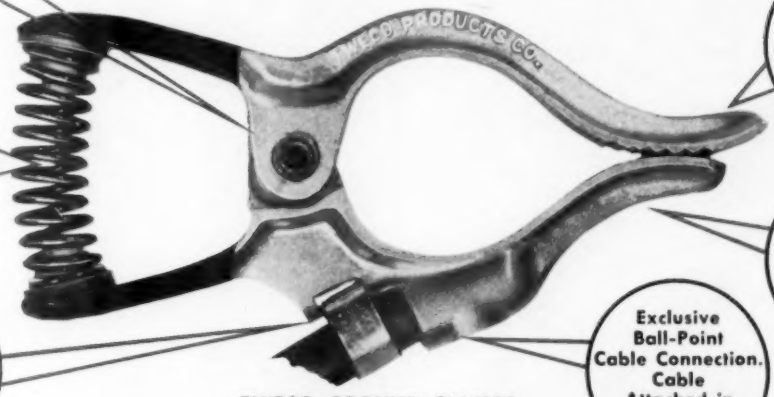
GIVES a quick, positive and portable ground connection.
INCREASES machine and operator efficiency.
ALLOWS proper placement of ground to eliminate arc blow.
MAKES holders and cable run cooler, last longer.
CUTS current consumption. Reduces power costs.

Only TWECO GROUND CLAMPS offer all these features:

Copper Hinge Pin Allows Both Jaws To Carry Current

Strong Spring Fully Insulated

Support Ring Stops Cable Strand Breakage



Extended Lip — Shoves on to Work Easily

Jaws Made of 98% Copper Alloy

Exclusive Ball-Point Cable Connection. Cable Attached in Two Minutes

TWECO GROUND CLAMPS MADE IN 200, 300 & 500 AMP SIZES

TWECO CABLE CONNECTORS

WRITE FOR FREE TWECOLOG SHOWING THE COMPLETE LINE OF TWECO ACCESSORIES

TWECOTONG ELECTRODE HOLDERS

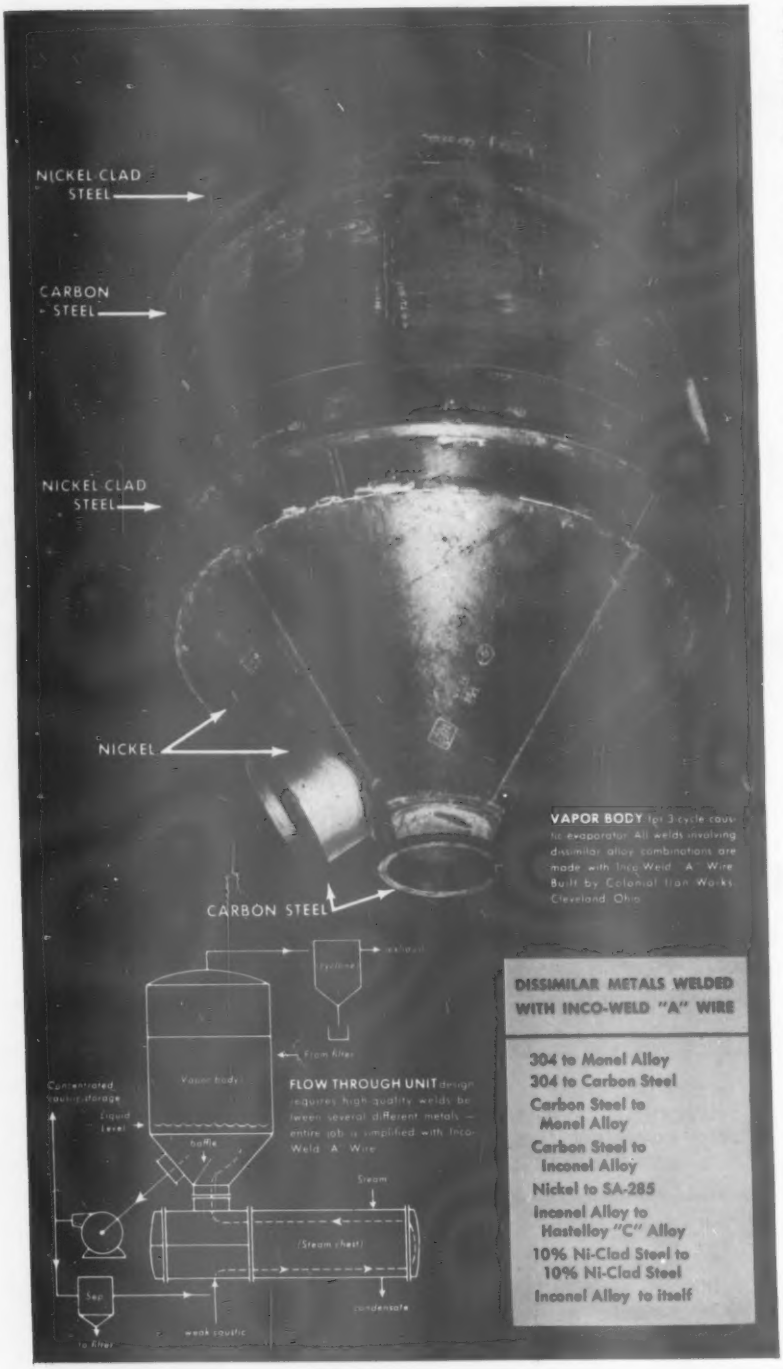
Tweco

MANUFACTURERS: ARC WELDING ELECTRODE HOLDERS, GROUND CLAMPS, CABLE CONNECTORS, TWECO-LITE ALUMINUM WELDING CABLE

PRODUCTS, INC.

P. O. BOX 666 • Factory: Boston at Mosley • Phone AMherst 5-1684 • Wichita 1, Kansas

New caustic evaporator demonstrates how well one filler wire ...Inco-Weld "A" wire...joins most dissimilar alloys


NICKEL CLAD STEEL
CARBON STEEL
NICKEL CLAD STEEL
NICKEL
CARBON STEEL
VAPOR BODY for 3-cycle caustic evaporator. All welds involving dissimilar alloy combinations are made with Inco-Weld "A" Wire. Built by Colonial Iron Works, Cleveland, Ohio.
cyclone
exhaust
From filter
Vapor body
Concentrated caustic storage
Liquid Level
baffle
FLOW THROUGH UNIT design requires high-quality welds between several different metals — entire job is simplified with Inco-Weld "A" Wire.
Steam
(Steam chest)
Sep.
condensate
weak caustic
to filter
DISSIMILAR METALS WELDED WITH INCO-WELD "A" WIRE
304 to Monel Alloy
304 to Carbon Steel
Carbon Steel to Monel Alloy
Carbon Steel to Inconel Alloy
Nickel to SA-285
Inconel Alloy to Hastelloy "C" Alloy
10% Ni-Clad Steel to 10% Ni-Clad Steel
Inconel Alloy to itself

This new 3-cycle evaporator produces high-purity caustic—maintains purity with all-Nickel surfaces. It is fabricated of Nickel, Nickel-clad steel, and carbon steel. All welds joining dissimilar alloys are made with Inco-Weld* "A" Wire.

Finished welds are sound, strong, ductile, and resistant to caustic corrosion. These superior welds are obtained with exceptionally high welding speed by using Inco-Weld "A" Wire and the inert-gas welding process.

Add these extras: (1) easily joins most combinations of dissimilar alloys, (2) no preheat necessary in most cases, (3) X-ray quality welds between 97 per cent of all weldable dissimilar alloy combinations (examples listed in table below), (4) good impact properties at sub-zero temperatures, (5) high stress-rupture properties at elevated temperatures, (6) Inco-Weld "A" *Wire* deposits can be age-hardened; important where super alloys are to be age-hardened after welding.

Whether you specify Inco-Weld "A" Wire or Inco-Weld "A" Electrode (for field welding and hard-to-get-at joints) you can expect sound welds. Corrosion resistance in most cases equals or betters that of the joined metals.

Illustrated folder — "Now You Can Weld Dissimilar Alloys," shows where and how Inco-Weld "A" Wire and Electrode cut costs, join most weldable dissimilar alloys. Just write us for your copy.

*Trademark, The International Nickel Company, Inc.

Inco-Weld "A" Electrode was formerly sold as Inco-Rod "A"* — this electrode has been improved so that it gives still greater hot ductility — particularly in heavy sections.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO WELDING PRODUCTS

electrodes • wires • fluxes